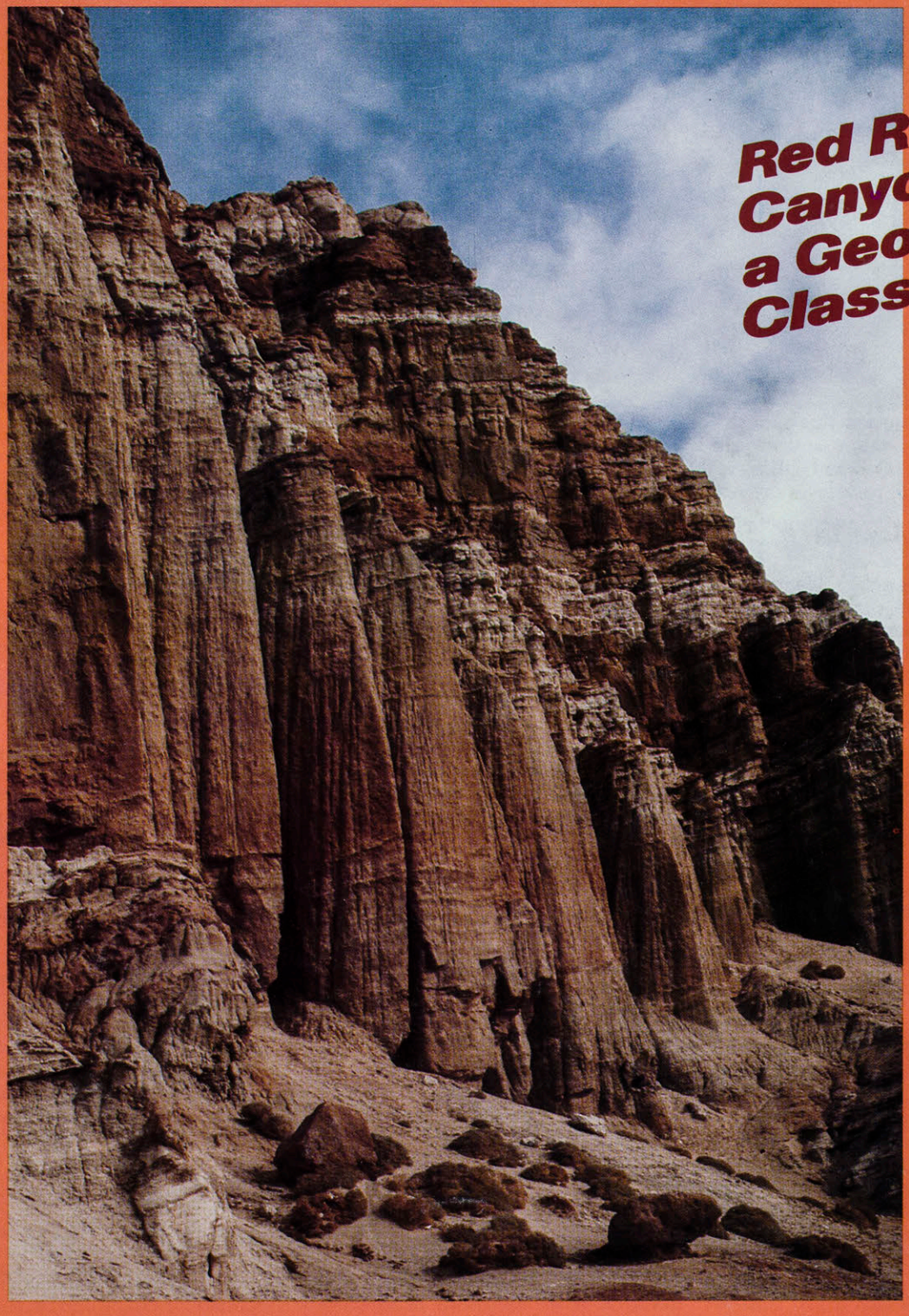
TERRA

THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

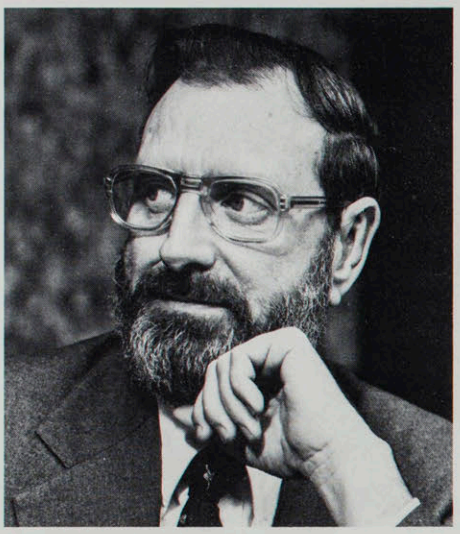
VOL. 21, NO. 2 / FALL 1982



Red Rock Canyon– a Geologist's Classroom

pg. 3

FROM THE DIRECTOR



Dr. Craig C. Black

As I write this I have had not quite one month on the job. That month has been full and exciting, challenging and rewarding. Of course, I still have much to learn, many people to meet, and a great deal of Museum space to explore. However, wherever I have turned this month for information, assistance and advice, I have found people ready and willing to do everything possible to help in my learning process.

One fact has become quite clear in my brief tenure—the Natural History Museum of Los Angeles County has a tremendous group of talented, experienced and enthusiastic people—staff, volunteers, and supporters—ready to get on with the job of making this one of the country's great museums. The membership will play a vital role in this endeavor and I look forward to working with the Alliance in developing new programs for members and building a broad membership base.

Los Angeles County has long provided the strong central core of support which is so essential to our Museum. It is my hope that this County support may be moderately increased in real dollars in the next two years so that some of the essential staff services which were curtailed after 1978 may be restored. However, it is to the private sector that I believe the Museum must turn for real growth in program activity. New exhibit halls such as the Dinosaur Hall, renovation of the Native North American Hall, the completion of the permanent History Hall must rely upon funds raised from the private sector. This is also true for our education programs and for an expanded special exhibition schedule. It is on the partnership of County support with private funding that we must build excellence for the future.

The next few months will be spent in developing long-range plans for Museum programs. All Museum staff will be involved in this task with final program priorities agreed upon by the Division Chiefs and myself. These long-range plans for exhibition and education programs, for collection conservation and storage, for staff development and for staff additions will then be presented to the Board of Governors and the Foundation Board for discussion and approval. We will then be ready to develop the necessary resources, both public and private, to implement the programs and to achieve our long-range objectives.

While this planning process proceeds, however, there are a number of immediate concerns that must be addressed. Funds must be raised to match a $200,000 challenge appropriation from the County for essential collection storage renovation for the Museum's fish, amphibian and reptile collection. Several special exhibitions must be scheduled for 1983 and early 1984 and funding for them secured. The Museum must also decide how it plans to participate in the celebration of the 1984 Olympics, now only eighteen months away.

CURATORS & COLLECTIONS

LETTER TO THE EDITOR

October 6, 1982

Ms. Dorothy H. Seligman
Editor, TERRA
Natural History Museum
of Los Angeles County
Exposition Park
Los Angeles, CA 90007

Dear Ms. Seligman:

The article "Learning to Live with Earthquakes" by Karen and Peter Ward (TERRA 21, No. 1/Summer 1982) gave your readers much valuable information regarding earthquake hazards. However, we feel that two important points were overlooked in the article. First, with our present state of knowledge it is possible to assign a relatively reliable lower bound to the probability for a great earthquake in the near future on the south-central locked segment of the San Andreas fault (the part of the fault between Parkfield and San Bernardino which broke in the 1857 Ft. Tejon earthquake). From the geological evidence obtained by Dr. Kerry Sieh, a lower limit of about 2% per year can be set at the present time.

This probability, of course, will in-

(continued on page 30)

TERRA

THE MEMBERS MAGAZINE OF
THE NATURAL HISTORY MUSEUM ALLIANCE
OF LOS ANGELES COUNTY

VOL. 21, NO. 2/FALL 1982

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Printed by North Hollywood Printing Co., Inc.
Color separations by Digital Dot
Typography by RS Typographics

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Red Cliffs along California Highway 14 near entrance to Red Rock Canyon. These cliffs are a frequent backdrop for movies and television commercials. They are formed by the ancient volcanic ash and stream deposits of the 10 million year old Ricardo Formation.



red rock canyon–

A GEOLOGIST'S CLASSROOM

by DAVID P. WHISTLER

Photographs by the author except where noted.

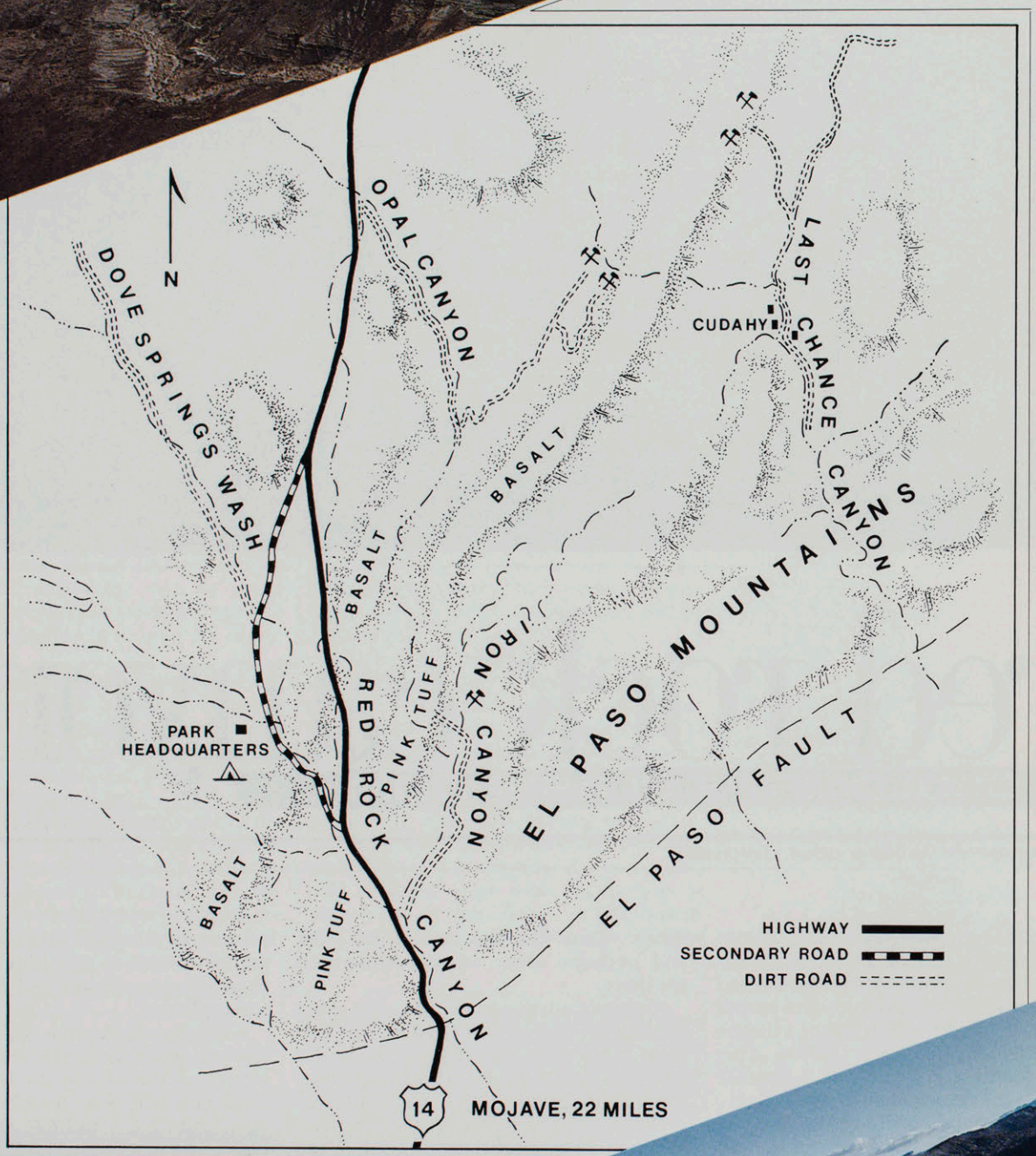
As vacationers and ski enthusiasts stream out of Los Angeles toward Mammoth and the eastern Sierra Nevada, they pass through a part of the Mojave Desert which leaves a lingering impression, Red Rock Canyon. This area of scenic cliffs has been a popular movie set for decades and many will recognize this backdrop from such films as "The Big Country" and "Capricorn 1" and from television commercials for Mercury Cougar and Wells Fargo Bank, the latter with the stagecoach crossing in front of the red cliffs. Recognizing the scenic beauty and recreational opportunities in close proximity to Los Angeles, the state of California has designated this area a State Park. Most people only pass through Red Rock Canyon, but for those who linger, the rewards are canyons filled with colorful badlands and ample desert wildlife in a remarkably unspoiled natural setting. All those passing through surely notice the spectacular red cliffs and perhaps some wonder why they are there.

A simple answer is the red cliffs are a product of geology and erosion. The full story is far more complex. To the geologist, Red Rock Canyon is a natural classroom. Not obvious to the casual observer is the fascinating geologic story that can be unveiled by careful observation of the scenic badlands. Rocks in Red Rock Canyon and the El Paso Mountains, through which the canyon passes, tell some of the one-half billion year history of this part of California. Several different rock formations in the area contain vertebrate and plant fossils which permit paleontologists to reconstruct a picture of the ancient life and environments. One of these, the Late Miocene Ricardo Formation, is particularly well-suited for fossil studies because it has produced seventy-eight different fossil animals ranging in size from giant, elephant-like gomphotheres to tiny shrews no bigger than a human thumb and nine different fossil plants.

Geologic exploration of the Red Rock Canyon area began in 1850 with the early surveys of the west by the Army Corps of Engineers who were searching for a suitable route for a railroad to the Pacific coast. The first published description and first use of the name "Red Rock Canyon" was by the Army geologist, G. K. Gilbert, in 1875. Fossils were first reported from this area in 1911 by C. L. Baker, a student of the famous paleontologist, Professor J. C. Merriam, from the University of California. Fossil collecting for the next nine years culminated in a review of the Ricardo fossil fauna published by Professor Merriam in 1919 and this work became a standard of comparison for similarly-aged fossil faunas throughout western North America.

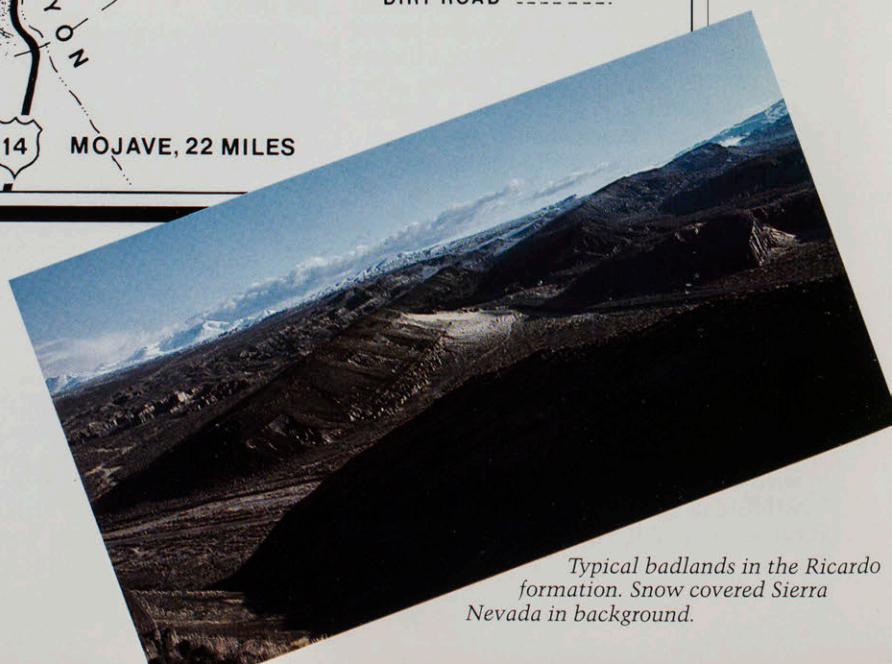


Typical badlands in the Ricardo Formation. Dark ridge tops formed by basalt flows. White bed near canyon bottom in center of photo is a volcanic ash which has yielded a 9+ million year old date for this part of the Ricardo Formation. Light colored beds are ancient lake and stream deposits which contain well-preserved fossils.



MUSEUM MEMBERS TOUR TO RED ROCK CANYON

The Museum Alliance, in conjunction with California Natural History Tours, is pleased to offer a special one day bus tour to Red Rock Canyon on January 22, 1983. Dr. David Whistler will be our guide. This all day trip will cost $32.50 per person. Museum members only. Please call the Alliance office 744-3427 for details and registration.



Typical badlands in the Ricardo formation. Snow covered Sierra Nevada in background.



Panoramic view of Iron Canyon portion of Red Rock Canyon State Park. Dark beds in middle distance are basalt flows in the Ricardo Formation. Rocks where photographer is standing are 100 million year old granites which are probably the same as those in the Sierra Nevada in background.

Between 1924 and 1925, two memorable amateur collectors, Misses Annie Alexander and Louise Kellogg, repeatedly ventured into the uninhabited badlands of the El Paso Mountains to collect fossils and modern plant and animal specimens for the University of California. Over forty years later, the postmaster and assayer at the nearby town of Cantil related how these two amateur scientists would disappear alone into the mountains in their Model "T" Ford and return weeks later loaded down with fossils. Ricardo fossils were also collected by J. W. Lytle of the staff of the Los Angeles County Museum of History, Science, and Art in 1925, thus beginning our collection from this area, a collection which today is more extensive than that of all other museums combined. The very first fossil specimen catalogued in the ledgers of the Vertebrate Paleontology Section is from the Ricardo Formation.

After World War II, the United States Geological Survey undertook a survey of the geologic resources of the Mojave Desert. This survey was under the supervision of Dr. D. Foster Hewett from the California Institute of Technology, who hired a couple of high school boys from Encino to search for fossils. Ten years later, in 1960, the author was introduced to the wonders of Red Rock Canyon by Dr. Richard H. Tedford, one of those Encino schoolboys, who had by then become an assistant professor of geology at the University of California at Riverside.

Returning to Red Rock Canyon, how, you ask, did the red cliffs form? Why are they red? How old are the rocks and fossils? How do we know there were volcanoes in the area and where are they today? To really understand these and other questions, the reader should have some knowledge of the methods employed by geologists. Our work is based on careful observation and the application of a few simple, although not all always obvious, principles. For example, we assume that processes and events occurring today must have happened in the past. Because most geologic processes happen over thousands or even millions of years, they cannot be directly observed and the geologist can only study their results such as the Grand Canyon of Arizona. The geologic history of our four and a half billion year-old planet is recorded by changes that have taken place on and below its surface. Geologists have developed an earth calendar called the Geologic Time Scale for this long history. The unequal divisions of the scale, each representing up to tens of millions of years, have been given names such as Miocene or Pleistocene that are as familiar to the geologist as the months of the year are to the layman. When assigning an age to a rock or rock sequence, the geologist is actually referring to the time it was deposited or formed in its present state.

The geologic history of Red Rock Canyon and the El Paso Mountains has been worked out by using the above principles. The first stage of an investigation is usually the compilation of a geologic map, the brightly-colored maps which adorn the walls of many geologist's offices. For this region, such a map reveals a general history of five periods of deposition separated by long gaps during which uplift and erosion repeatedly occurred.

The oldest rocks are in the central part of the El Paso Mountains. They are 225 million-year-old marine sediments called the Garlock Series deposited on hard, crystalline rocks over 500 million years old called the Mesquite Schist. The marine Garlock Series supports similar evidence found elsewhere in western North America indicating this portion of the present-day continent had not emerged from the ocean.

The oldest rocks in Red Rock Canyon are those exposed in the gorge at the entrance to the canyon. These are granite-like rocks which formed from melted rocks deep in the crust of the earth. They are probably the same rocks which formed the core of the Sierra Nevada Mountains about 100 million years ago.

No rocks in the Red Rock Canyon area record the events between 100 million and fifty-eight milion years ago. However, the Garlock Fault, which would have a dominant influence on the subsequent geologic history of the area, developed nearby during this time. It is one of the largest in California, traceable for over 150 miles across the northern side of the Mojave Desert. The present-day effects of the Garlock Fault are clearly visible as the steep, eastern slopes of the Tehachapi



Top: Camping area and typical exposure of the Ricardo Formation in Red Rock Canyon. These cliff-forming beds are ancient stream deposits.

Center: Fossil collecting in typical badlands of the Ricardo Formation. Fossils and matrix collected from this locality must be transported on foot for over one mile to nearest highway. White bed in cliff in lower right corner is volcanic ash.

Bottom: Fossil collecting in Ricardo Formation. Portable jackhammers are used to excavate in these ancient stream deposits which have hardened to stone over the past 10 million years. This locality yielded some of the oldest vertebrate fossils from the Ricardo Formation.

Mountains west of the town of Mojave and the long depression of Fremont Valley east of Red Rock Canyon. Evidence along the Garlock Fault suggests that the rocks on the south (Fremont Valley) side have moved at least thirty miles to the east in relation to the rocks on the north side of the fault.

The El Paso Mountains and Red Rock Canyon have been uplifted and tilted along the El Paso Fault, a branch of the Garlock Fault. Total uplift cannot be calculated because part of the geologic record is missing, but it must be at least 35,000 feet (six and a half miles) since the bottom of the marine Garlock Series is exposed at the present-day surface. These marine rocks, which were originally deposited horizontally, were tilted to nearly vertical during this uplift. The actual break in the rocks caused by the El Paso





Fault can be seen on both sides of the entrance to Red Rock Canyon.

About fifty-eight million years ago, near the end of the Paleocene Epoch, streams from a distant source to the north and northeast began depositing boulders and gravels in valleys cut into the uplifted core of the El Paso Mountains. Several times the streams flooded the area with a lake or swamp in which dead plants accumulated to form coal

beds. This process continued until 6500 feet of stream and lake beds accumulated. These ancient deposits, called the Goler Formation, have yielded a few scattered fossil vertebrates including the oldest records of mammals in California. Comparison of these with fossils found in New Mexico and Wyoming tell us the Goler Formation is Paleocene in age. The Goler Formation is the only non-marine, fossil producing unit of this age in California, Arizona or Nevada; thus it provides the only glimpse of life during the Paleocene over a large portion of the West.

Events of the next forty million years are unknown because no rocks were deposited during this interval. Around eighteen million years ago most of the El Paso Mountain area and much of the western Mojave Desert were inundated by volcanic ashes and flows now called the Tropico Group, a name derived from the famous gold and silver mine near the town of Mojave. Most of these deposits were airborne ashes and tuff breccias similar to those recently erupted by Mt. Saint Helens. Like the current situation at Mt. Saint Helens, much of this ash was washed by rain into streams and lakes where it accumulated as sticky muds. These volcanic muds sometimes preserve the trackways of ancient animals and many fossil trackways of camels are found at several horizons in the Tropico Group volcanics in Last Chance Canyon. The area near the entrance to Red Rock Canyon was elevated during this time and these volcanics were stripped by erosion as fast as they accumulated, but at least 3000 feet accumulated in a local valley six miles to the northeast. These volcanic ashes are the yellow, white, tan and bright pink beds exposed around the ghost town of Cudahy.

The last pulse in this Middle Miocene volcanic episode was the outpouring of andesite breccia lava flows. The molten lava reached the surface through numerous cracks rather than from a single volcano, and some of these andesite-filled cracks, called dikes, can be seen in Last Chance Canyon. These andesite breccia flows form the top of Black Mountain, the high point in the El Paso Mountains, and can be traced continuously to within one mile of Red Rock Canyon. They have been dated, using radiometric techniques, at between 15.1 and 17.2 million years old.

The next recorded episode in the local geologic history began when boulders and gravels from the surrounding hills and more distant sources to the east filled valleys cut through the andesite breccias and volcanic tuffs of the Tropico Group. These conglomerates are the earliest deposits of the Late Miocene Ricardo Formation, a sequence of over 6100 feet of sediments which dominates the Red Rock Canyon area. The name "Ricardo" is derived from the old Ricardo gas station and store which used to be at the present-day site of the State Park Headquarters. As these local valleys were filled, the area to the northwest was flooded by a shallow lake which persisted for the next million years. The light colored sediments that dominate Last Chance Canyon and the light green and gray beds in Red Rock Canyon were deposited in this lake.

Most of the other red, tan and yellow, cliff-forming rocks in Red Rock Canyon were deposited by ancient streams which flowed into the lake and through the valley surrounding the lake. These rocks, which are gray below the surface, often weather red or orange because of the oxidizing (rusting) of iron-rich minerals common in these stream deposits.

Nearby volcanoes had a pronounced influence on shaping the landscape as the ancient Ricardo valley slowly filled with stream and lake deposits. The area was blanketed by more than twenty-five volcanic ashes and lava flows. Some of these form the ridges which dominate the area today including the red cliffs near the entrance to Red Rock Canyon which are capped by a pink and yellow tuff breccia. This cliff-forming bed continues over six miles to the north. Further up the canyon near the Park Headquarters are several ridges capped by dark rocks which are basalt flows that spread out across the ancient Ricardo valley. These ancient flows produce ridges which can be seen running for miles to the northeast.

Not obvious to the untrained eye are seventeen volcanic ashes which blanketed the area at fairly evenly-spaced intervals. The two most prominent volcanic ashes were mined in Last Chance Canyon between 1922 and 1947 for abrasive used in Old Dutch Cleanser. These volcanic ashes also appear as the white bands in the cliffs in Red Rock Canyon. They are well-suited as stratigraphic markers since a single ash less than a foot thick can typically be traced for over six miles. These beds have provided the radiometric dates which indicate the Ricardo Formation ranges in age from 8.2 to 10.1



Air photograph of Red Rock Canyon taken in 1952. Dark bands are basalt flows within Ricardo Formation. Thin dark line running across middle of photo is California Highway 14. Thin lines and symbols are geologic field mapping.



Diorama depicting the scene in the Red Rock Canyon area as it may have appeared 10 million years ago. Animals, vegetation and terrain based on evidence gathered from the Ricardo Formation. Photo taken from diorama in Hildegarde Howard Cenozoic Hall in museum.



Photo: Dick Meier

Fossil lizard bones from the Ricardo Formation. Note the eye of a needle for scale. These specimens were recovered using an underwater, screen sieving fossil collecting process.

million years old.

Beds in the upper part of the Ricardo Formation up Dove Springs Wash and along the Powerline Road are ancient alluvial fans and hardpan soil deposits which indicate increased uplifting of hills to the south and west of the Ricardo basin. Some of these contain stringers of well-rounded granitic boulders, some larger than automobiles, which were probably derived from the newly-emerging Sierra Nevada Mountains. The top of the Ricardo Formation is not exposed, thus the end of its depositional story cannot be told.

The El Paso Fault resumed its activity sometime after the Ricardo Formation was deposited and the El Paso Mountains were uplifted at least 5000 feet. This uplifting tilted the Ricardo sediments 15–25 degrees to the west and erosion removed them from the top of the El Paso Mountains. Sometime later, alluvial fan and stream deposits spreading out from the Sierra Nevada Mountains completely buried the area of Red Rock Canyon except for the tops of the basalt and tuff breccia ridges. These deposits contain fossils which suggest these alluvial fans are no more than 25,000 years old. Remnants of these fan deposits occur as flat-lying, yellow and white sands on the ridge south of the Park campground. Renewed erosion, probaby beginning only in the last one-to-two-thousand years, cut the gorge at the entrance to Red Rock Canyon and sculptured the colorful badlands in an erosional cycle which continues today.

There is also a rich fossil story in Red Rock Canyon. When J. C. Merriam published his report on the Ricardo Formation in 1919, he recognized twenty-two different species. The subsequent efforts of many professional and amateur workers and the application of newer collecting techniques during the past fifteen years have increased this count to seventy-eight species. Undoubtedly, many more are yet to be discovered.

Fossil collecting requires both luck and skill. Most large animal fossils occur as single bones or pieces of bone in the Ricardo Formation. Most of these bones are further broken by weathering before discovery. What the paleontologist usually finds is a small piece of fossil on the surface which may be the entire find or may indicate that a more complete specimen is below the surface.

Fossils of smaller animals the size of mice or lizards are also present in the Ricardo Formation, but these small fossils cannot be as readily seen as the larger bones, and, therefore, different collecting techniques are used. The process involves collecting lage quantities of rock from fossil-producing localities, breaking down this rock in various chemicals and allowing most of the rock to pass through fine screens leaving the fossils behind.

Fossils of larger animals are usually found in stream deposits of the Ricardo Formation and we assume that dead animals were washed into the ancient streams and carried along until the bones were buried. Concentrations of larger bones are occasionally encountered; most of these appear to have accumulated in and around small ponds which probably were watering holes where the Ricardo animals congregated.

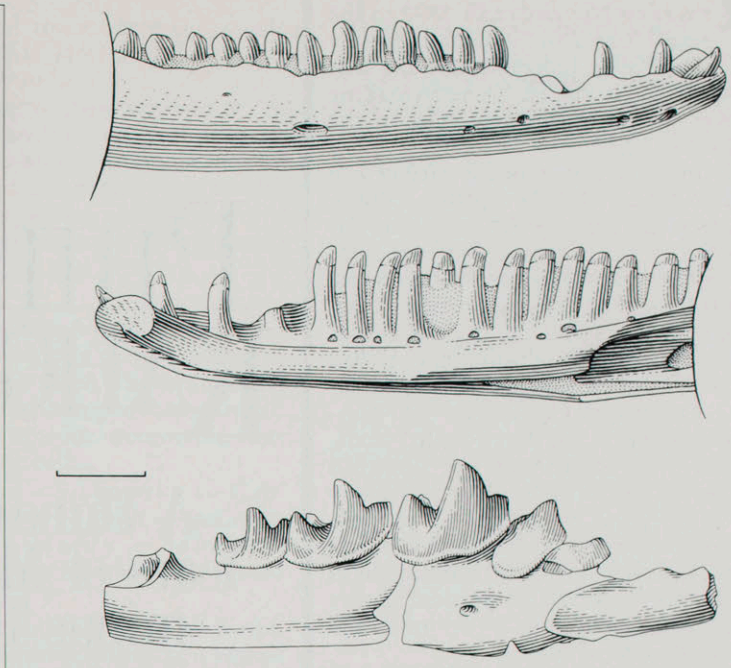
In contrast to the larger fossils, most of the fossils of smaller animals are found in concentrations either in silty pond deposits or in unique masses of fossil bone interpreted as ancient carnivore dens. In both cases, these concentrations probably result from actions of ancient predators. A modern example of such a concentration is the piles of regurgitated pellets of bones and fur commonly found below owl roosts and nests. Modern owls often roost in trees, and were these along streams and around ponds, it would be easy to visualize how a similar situation in the past would lead to a concentration of small bones buried in pond deposits.

The fossils recovered from the Ricardo Formation are diverse, representing many ancient habitats. Although lake beds are common, surprisingly only one small fish, a sucker, has been recovered. Water-loving animals including frogs, toads, three kinds of salamanders, a pond turtle, an extinct goose, an otter and a small species of beaver indicate presence of ample, fresh water. In contrast, long-

Photo: Dick Meier



Skull and jaw of very large fossil cat, Nimravides, *collected from the Ricardo Formation by Ms. Beth Chasse, amateur paleontologist and museum field associate. This extinct cat, as large as a modern lion, is the largest Miocene cat in North America.*



Top and center: Illustration of right lower jaw of fossil alligator lizard from the Ricardo Formation referred to modern genus Gerrhonotus. *Scale line equals 1 mm or about 1/25 inch.*

Bottom: Ilustration of right lower jaw of one of the four species of fossil shrews from the Ricardo Formation. Scale lines equals 1 mm or about 1/25 inch.

legged running animals like two different rhinos, ten species of horse, four kinds of camels and three prongbuck antelope species suggest open plains. Two elephant-like gomphotheres, a vulture, two large land tortoises, a pika, two ground squirrel species, and deermice and rabbits also frequented this habitat. Brush-loving animals are represented by two oreodonts (extinct sheep-like animals), a peccary, a three-toed browsing horse, a short-legged camel, a ringtailed cat, a small skunk, two weasel-like animals, a wolverine, two foxes, four distinctly different spiny lizards, a night lizard, rosey boa and racer snakes, a hedgehog, a chipmunk, two gopher-like rodents, two different pocket mice, a bat, and at least three small perching birds. A mole, four different shrews, a small, rear-fanged snake and two alligator lizards probably frequented areas near permanent water. Six different species of dog, a very large bear-like animal and three large cats including a sabretooth probably moved anywhere they pleased.

Many of these animals have been found as fossils only in the Ricardo Formation. First records, or type specimens of seventeen fossil species have already been described. Work over the past five years has yielded at least one new species for each collecting trip to the area. In contrast, certain fossil animals which would be expected have not yet been recovered, but many will undoubtedly be found on future trips.

Although the Ricardo Formation has many different types of vertebrate fossils, the reader should realize that fossils in this area are actually quite rare and they are protected by California and Federal laws. Fossil collecting is strictly regulated by the State Park and the Bureau of Land Management. Collecting permits are issued to qualified researchers and institutions. The Natural History Museum of Los Angeles County welcomes the assistance of all who are willing to learn and practice proper collecting and data recording techniques. In the absence of such training, the well-meaning amateur could unknowingly destroy the best or only record of an animal new to science. The fossil record is incomplete, and all fossils from this area are important to completing this story.

The Red Rock Canyon area is still geologically active and the scene will certainly be much different in the future. If geologic trends which have been in effect for the past few thousand years continue, the El Paso Mountains will continue to rise along the El Paso Fault and the rocks of the Ricardo Formation will erode away and be redeposited in the Fremont Valley. Thus will begin a new cycle in the ever changing surface of the earth.

Next time the reader passes through Red Rock Canyon, perhaps he will have a different sense of monumental events happening, even if they are too slow to perceive. Certainly this area is beautiful and interesting to behold, but it is also a book of earth history waiting to be read for those who will linger long enough to look at the individual pages.

The author wishes to gratefully acknowledge the assistance of all the past and present staff of the Red Rock Canyon State Park who have measurably assisted the work in Red Rock Canyon. I would also like to thank the many volunteers whose efforts have significantly improved the knowledge of the fossil record of the Ricardo Formation. Support for these ongoing studies has been provided by the Annie Alexander Endowment to the University of California Museum of Paleontology, the University of California at Riverside, the Natural History Museum of Los Angeles County and its Foundation and the National Science Foundation (Grant DEB 7202014). Collecting permits were issued by the United States Department of the Interior and the California State Park Department.

Dr. David P. Whistler is a curator of Vertebrate Paleontology at the Natural History Musem. He has been studying the Red Rock Canyon area for more than twenty-five years, and will be leading a Museum Alliance sponsored trip there on January 22, 1983.

PHILIP KAHGAN

A Hundred Years of Music-minus Ten

by RICHARD LIPSCOMB

It was on November 14, 1892 in the small town of Telechan, Russia that Philip Kahgan made his first sounds in the world. He has been making a noise, a very mellifluous one, in the world ever since.

His musical career in the city of Los Angeles began when he became a member of the Los Angeles Philharmonic Orchestra in 1921. Associate Principal violist of the Los Angeles Philharmonic Orchestra for twenty years, where he appeared as viola soloist an unprecedented seven times under conductors Arthur Rodzinski, Albert Coates and Otto Klemperer, Orchestra Contractor for Paramount Studios for forty-eight years, builder of orchestras for Leopold Stokowski, Bruno Walter, Igor Stravinsky and other great musicians of our age, music director of this Museum's concerts for thirty-seven years, Phil Kahgan has in untold ways reflected the musical history of Los Angeles both as a performer and shaper of musical events.

In 1928, concurrent with his performing with the Los Angeles Phiharmonic, Phil Kahgan joined Paramount Studios and began building the orchestras and musical background for a different kind of celebrity, the movie stars of the 30s, 40s, 50s, 60s, right up to his retirement from Paramount in 1976 after forty-eight years with the Studio. From Maurice Chevalier and Jeannette McDonald, Ernst Lubitsch, and the "Road" pictures of Bing and Bob through Elvis Presley and all in between down to "Love Story," Phil Kahgan was a part of the history of the movies in Hollywood.

Another aspect of his performing life was as a violist with the Noack String Quartet, the Bartlett Frankel String Quartet, with the Borris Morros String quartet on CBS radio coast to coast every Sunday morning from 11:30 to noon, the Los Angeles Philharmonic Quartet, the Paramount Quartet and others.

In 1941 he assembled the orchestra for the Werner Janssen Symphony which broadcast as the Standard Symphony Hour on the West Coast. Phil continued as orchestra manager and soloed a number of times on the programs. In 1943 he was asked to form the Mozart Orchestra of California at Occidental College for British conductor Anthony Collins.

During the war years Phil was untiring in his efforts; he regularly supplied the finest of orchestras for the Hollywood Canteen. He arranged for a 100-piece orchestra to go to March Field, with Leopold Stokowski as conductor. After that concert, Phil reached a hand down to help a short, gritty general named George Patton leap up on the stage and thank "Stokie." Phil arranged for orchestras to visit hospitals: Birmingham Hospital in the Valley, Naval Hospitals, wherever servicemen were recuperating or lay hurting. Phil took smaller groups to visit and entertain. Franz Waxman and Victor Young conducted orchestras that Phil assembled for these morale-building visits.



Phil Kahgan at sixteen in his home town, Telechan, Russia, in 1908. Phil is at left with his violin. The other two members of this young trio are: center, Nisell Melnick, trombone, and his brother, Hershell Melnick, trumpet. They played for many events in Pinsk.



Philip Kahgan, 90 years old on Sunday, November 14, 1982.



Philip Kahgan during his Philharmonic Orchestra tenure as Associate Principal violist.

It was in 1945 that Phil took an orchestra he had assembled, with Victor Young conducting, to play before the Los Angeles County Board of Supervisors, which resulted in the Supervisors' bestowal of $150,000 to fund performance of concerts in the County. This support of music by the County has continued since that time.

In 1945 Phil began supplying programs and personnel for chamber music concerts at this Museum, initiating the series. Museum concerts, broadcast live from the Musuem by KFAC each Sunday of the year beginning in 1950, have continued down to this day and now comprise in excess of 1700 concerts arranged for and coordinated by Phil in those thirty-five years, concerts described by the Trustee of the Music Performance Trust Fund, of the Recording Industry, one of the fundors of the concerts, as "by long odds the most distinguished series of performances from an artistic point of view presented anywhere by the Trust Funds."

In 1945, Phil was asked to go to New York to complete arrangements with Leopold Stokowski which resulted in Stokowski coming to Los Angeles as Music Director and Conductor of the Hollywood Bowl concerts. Phil assembled the musicians for the two consecutive seasons Stokowski continued as conductor at the Bowl. This was part of a long and close association Phil had with Stokowski, extending even to letters and phone calls from "Stokie" in which he asked Phil to criticize the musical balance for his later broadcasts from New York.

John Williams, the composer of "Star Wars" music and many other fine motion picture scores and now conductor of the Boston Pops Orchestra, refers to Phil's famous cellar where autographs of the musical greats of the twentieth century are inscribed:

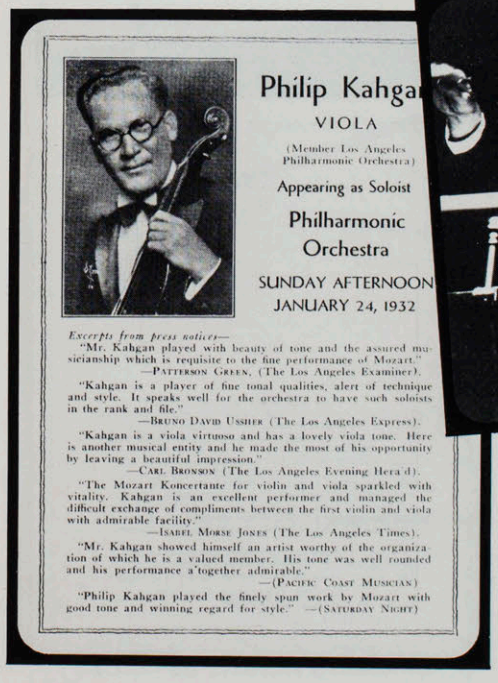
> Dear Phil,
>
> After a thrilling 3 days of recording with an absolutely perfect orchestra that you provided, the only thing that could have topped the occasion, and it did, was our memorable visit in your wine cellar.
>
> Stravinsky — Stokowsky — Gabrolowitch *(sic)* — Brain — and even Hamilton Hardy — fabulous memoirs of a rich life deeply devoted to music.
>
> Thank you so much for your hospitality. It was an honor to be a visitor at a place where so many immortals have preceded us.
>
> With gratitude and all best wishes to you and your charming wife.
>
> Yours truly,
> John Williams

In 1946 Franz Waxman asked Phil to be orchestra manager for his Los Angeles Music Festival, an assignment that lasted for the twenty years of the Festival until Waxman's death.

In 1949 Phil initiated a chamber music series for Cal Tech in its Dabney Lounge, a series Phil continued for many years.

1957 saw the beginning of an extra special musical experience in this very special musical life. Phil was asked by Columbia Masterworks Records to assemble an orchestra for Bruno Walter to record the four Brahms and nine Beethoven symphonies. The windowless American Legion Hall on Highland Avenue south of the Hollywood Bowl is considered by many as an almost perfect room for recording, and it was there that these historic performances took place. The finest players in Los Angeles, handpicked by Phil, gladly forsook the more lucrative motion picture studio jobs and counted it gain when called upon by Phil to play for the master, Bruno Walter. Commenting on the flexibility of style and quickness of grasp of this orchestra, Dr. Walter remarked that it was "unsurpassed in my experience." For many musicians and critics these recordings are considered the definitive ones of Brahms and Beethoven. That same orchestra known as the Columbia Symphony went on, with Phil as orchestra manager, for a four-year period to record Mozart, Wagner, Schubert, Mahler and Bruckner. Igor Stravinsky and Robert Craft also recorded a large repertoire of Stravinsky works with the Columbia Symphony.

In 1966 Phil became orchestra contractor for the Glendale Symphony Orchestra, a position he held for eleven



Playbill for an appearance by Philip Kahgan with the Los Angeles Philharmonic Orchestra. One of his seven appearances as soloist with the Orchestra.



Man behind the Music; Philip Kahgan with Dr. Bruno Walter at a recording session of the Columbia Symphony Orchestra in 1959



Philip Kahgan with Leopold Stokowski at the Hollywood Bowl, 1945. The young lad at the left is Sheridan Stokes who grew up to be one of the finest flutists in Los Angeles. To his right his father, Franklyn Stokes, associate orchestra contractor at the Bowl, Phil Kahgan, supervisor of the Orchestra, "Stokie," and behind him the fine musician Richard Hammond. This picture was taken by Gloria Vanderbilt Stokowski.



Philip Kahgan at Igor Stravinsky's elbow during a pause at a recording session with the Columbia Symphony Orchestra in 1960.

133 EAST 80TH STREET

June 9, 1939.

Philip Kahgan, Esq.,
% Paramount Studios,
Hollywood, Calif.
Dear Mr. Kahgan:

I have just returned to New York with nothing but the happiest recollections of my stay in Hollywood and especially of the splendid orchestra which you gave me for our recording of Beethoven's Finale of his Fifth Symphony. Please give them all my best greetings, together with the hope that I may be permitted at some future time to lead them again.

Very cordially yours,

Walter Damrosch

Letters to Philip Kahgan:
June 9, 1939—Walter Damrosch

23
March
1941

Mr. Phil Kahgan
723 North Citrus Avenue
Hollywood, California

Dear Phil

I have just arrived here and find your bill and am enclosing a check.

It was a wonderful orchestra you assembled and I look forward with pleasure to future things we shall do together because I always like so much working with you. Every now and then you do something which is really a miracle.

Always your friend

Leopold Stokowski

1716 Rittenhouse Street
Philadelphia
Pennsylvania

AM

March 23, 1941—Stokowski

Fairmont Hotel
San Francisco

January 17th, 1949.

Dear Phil:

I am still so strongly under the impression of the Saturday night concert that I cannot refrain from dropping these lines. This concert was one of the rare events in an artist's life and I fully realize that nobody would have been able to achieve this performance without you. This was your baby! the choice of those wonderful musicians, the arrangement of rehearsingtime and what not else! Thousand thanks again - I will not forget this because it was the realization of a dream.

Then you see the men please tell them again my thanks and my admiration for their playing and their spirit.

Cordial greetings from both of us us to you and Mrs. Kahgan,

yours most sincerely

William Steinberg

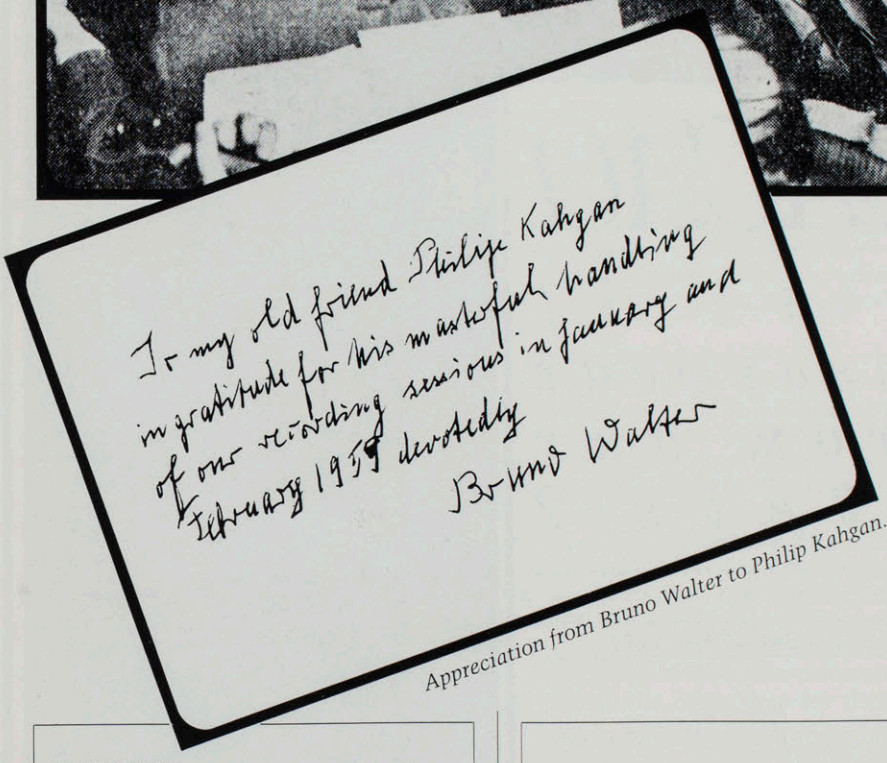
William Steinberg

P.S. When do you come to San Francisco? Aren't youa Mahlerfan by now?

January 17, 1949—William Steinberg

Phil Kahgan at extreme right as an orchestra he assembled plays for the Los Angeles County Board of Supervisors, Wednesday, March 28, 1945, Victor Young conducting. After this serenade the Supervisors voted $150,000 to present music concerts in the County.





Appreciation from Bruno Walter to Philip Kahgan.

years until his resignation was reluctantly accepted by Carmen Dragon, music director, at a time when Phil was lightening the load of programs he had assumed over the years.

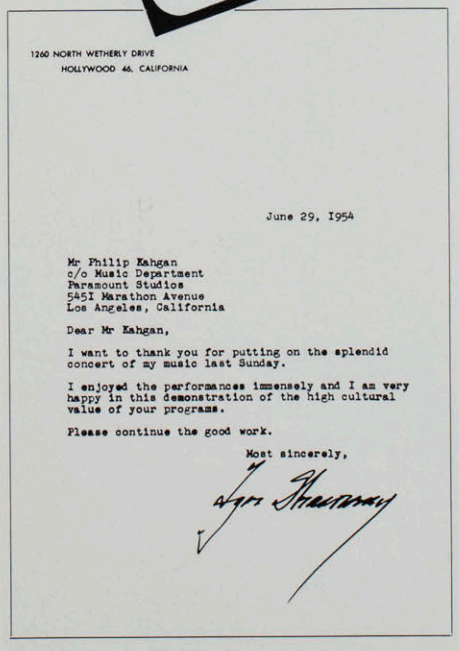
There are too many important musical organizations to mention adequately in an article of this brevity, such as those like the San Francisco Opera Company in Los Angeles, the Pasadena Opera Company, the Los Angeles Master Chorale, the Inglewood Symphony at its inception, the Beverly Hills Symphony, and the list could go on.

During part of his early career violist Phil Kahgan made it a habit to film the great conductors and musicians under whom he played from his vantage point in the orchestra. Igor Stravinsky, Bruno Walter, Arnold Schoenberg, Otto Klemperer, Leopold Stokowski are only a few he had photographed at work. Now these invaluable documents are to be stored at U.C.L.A. in its Archives Collection.

Now that Phil Kahgan has resigned the other musical activities in which he was engaged so busily over these many years, we at the Museum are fortunate indeed that the one project he has not resigned is the Museum Concert Series. Each Sunday of the year he comes to the Museum to supervise the musicians he has engaged for that day's concert and to perform an additional one of the functions Stokowski so praised him for—getting a correct microphone balance of instruments for the broadcast.

Happy 90th Birthday, Phil Kahgan.

Richard Lipscomb is Chief of the Education Division at the Natural History Museum and claims that working with Phil Kahgan has been one of his most enriching experiences.



1260 NORTH WETHERLY DRIVE
HOLLYWOOD 46, CALIFORNIA

June 29, 1954

Mr Philip Kahgan
c/o Music Department
Paramount Studios
5451 Marathon Avenue
Los Angeles, California

Dear Mr Kahgan,

I want to thank you for putting on the splendid concert of my music last Sunday.

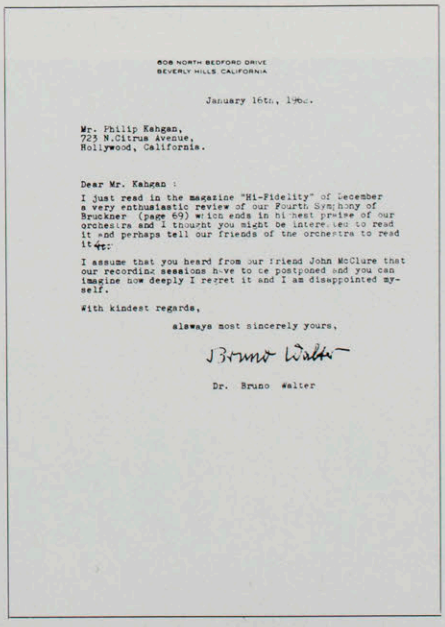
I enjoyed the performances immensely and I am very happy in this demonstration of the high cultural value of your programs.

Please continue the good work.

Most sincerely,

Igor Stravinsky

June 29, 1954—Igor Stravinsky



608 NORTH BEDFORD DRIVE
BEVERLY HILLS CALIFORNIA

January 16th, 1962.

Mr. Philip Kahgan,
723 N.Citrus Avenue,
Hollywood, California.

Dear Mr. Kahgan :

I just read in the magazine "Hi-Fidelity" of December a very enthusiastic review of our Fourth Symphony of Bruckner (page 69) which ends in highest praise of our orchestra and I thought you might be interested to read it and perhaps tell our friends of the orchestra to read it too.

I assume that you heard from our friend John McClure that our recording sessions have to be postponed and you can imagine how deeply I regret it and I am disappointed myself.

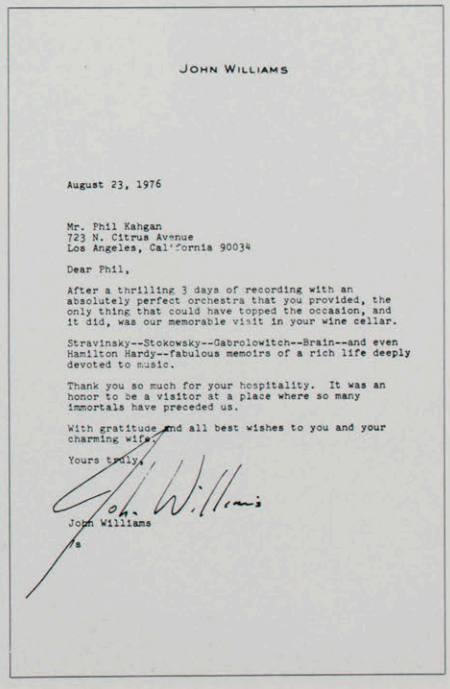
With kindest regards,

always most sincerely yours,

Bruno Walter

Dr. Bruno Walter

January 16, 1962—Bruno Walter



JOHN WILLIAMS

August 23, 1976

Mr. Phil Kahgan
723 N. Citrus Avenue
Los Angeles, California 90034

Dear Phil,

After a thrilling 3 days of recording with an absolutely perfect orchestra that you provided, the only thing that could have topped the occasion, and it did, was our memorable visit in your wine cellar.

Stravinsky--Stokowsky--Gabrolowitch--Brain--and even Hamilton Hardy--fabulous memoirs of a rich life deeply devoted to music.

Thank you so much for your hospitality. It was an honor to be a visitor at a place where so many immortals have preceded us.

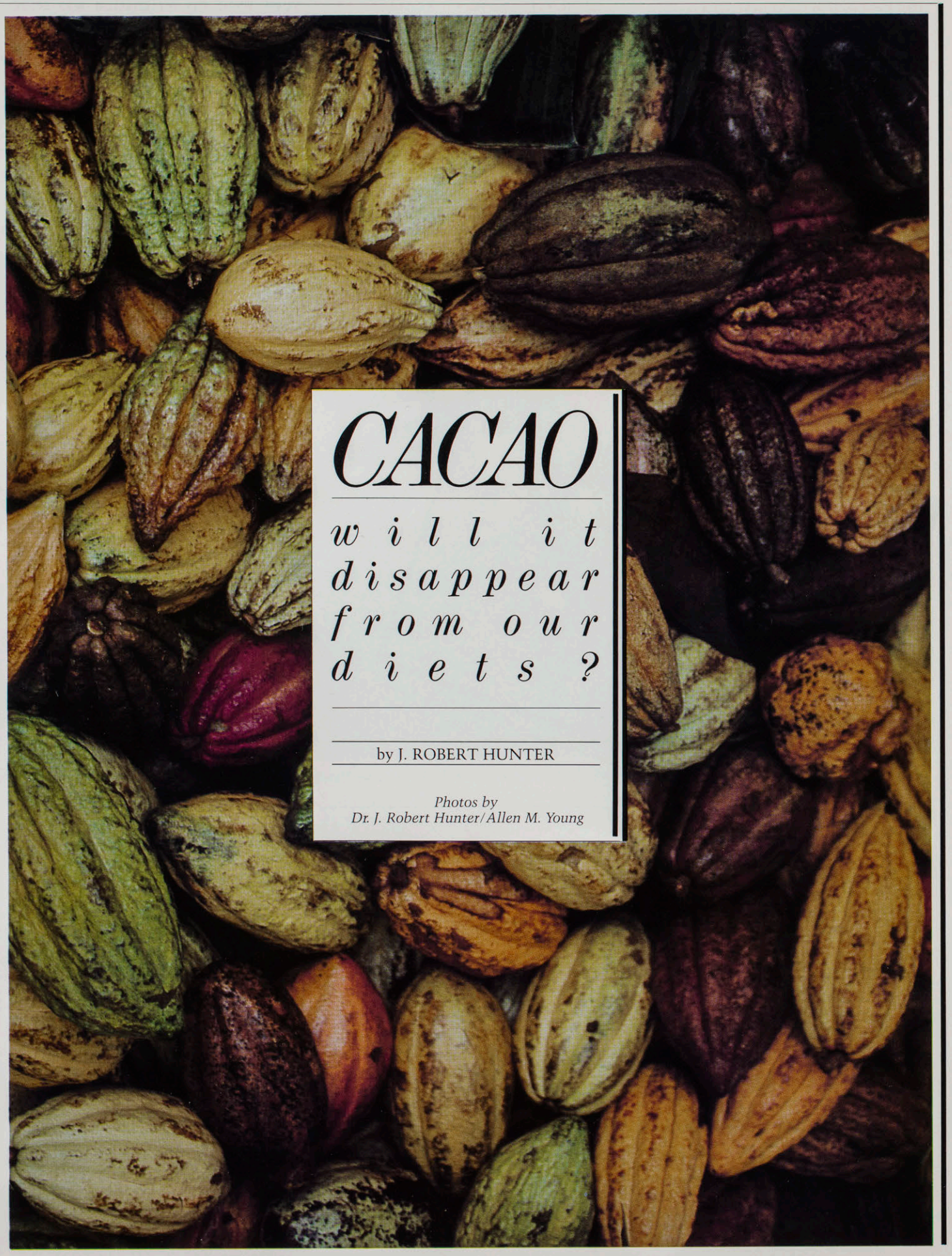
With gratitude and all best wishes to you and your charming wife,

Yours truly,

John Williams

John Williams
/s

August 23, 1976—John Williams



CACAO

will it disappear from our diets?

by J. ROBERT HUNTER

Photos by
Dr. J. Robert Hunter/Allen M. Young

Among the earliest descriptions in English of the cacao tree and its products are those of Thomas Gage. He explained that the trees from which the fruit is harvested were called "cacvaqualhitl," the cacao fruit or pods "cacavacentli," the cacao beans "cachoatl" and the drink made from these beans "chocolatl." According to Gage, "the name is compounded from 'atle,' as some say, or as others, 'attl,' which in the Mexican language signifieth 'water' and from the sound which the water (wherein is put the chocolate) makes as choco-choco-choco when it is stirred in a cup by an instrument called a 'molinet' or 'molinillo' until it bubble and rise into a froth." The scientific name for the cacao plant is *Theobroma cacao.* Since the Indians of the new world believed it to be of divine origin, Linnaeus gave it the generic name *Theobroma* from the Greek, meaning "food of the gods." The species he called *cacao* from reports such as Gage's.

Today, the tree and its parts or the crop are still called cacao. However, the word "cocoa" is regularly used as soon as the crop is unloaded in a major consuming country. There is some confusion over this, but even if the name was misspelled by changing the positions of the a's and o's, the mistake stuck. It is really not too important an issue, for the name will probably continue to remain cacao for the tree and its parts in Spanish-speaking Latin America, cacau in Portuguese-speaking countries and cocoa in most of the rest of the tropics.

Prescott writes in his *Conquest of Mexico,* "Among the most important articles of their (Aztecs) husbandry ... was the cacao, the fruit of which furnished chocolate — from Mexican Chocolatl." He went on to describe how the "Emperor took no other beverage than the *chocolatl,* a potation of chocolate flavored with vanilla and other spices and so prepared as to be reduced to a froth of the consistency of honey which gradually dissolved in the mouth. The beverage, if so it could be called, was served in golden goblets with spoons of the same metal or of tortoise shell finely wrought. The emperor was exceedingly fond of it to judge from the quantity—no less than fifty jars or pitchers — prepared for his own daily consumption. Two thousand more were allowed for that of his household."

This report provides a notion about the preparation and consumption of chocolate in those days, at least for people of power and influence. The beans came to Mexico from as far away as what is now Costa Rica, and always by ocean from distances that great. Most of these beans were reported to be tribute to the Aztec Emperor.

I am quite prepared to believe that not all of the Spaniards in the days of the Conquest really enjoyed the drink, exotic as it may have been, for the Aztecs used only small amounts of honey to sweeten this concoction and even with such ingredients as vanilla added, it must have been rather bitter for most European palates.

The reason chocolate was used in the New World by those who could afford it was undoubtedly due as much to the stimulating effect of the alkaloid, theobromine, which the beans contain, as to its taste. Probably one could arouse the senses as much from drinking a thick mixture of pulverized cacao beans in water as by masticating coca leaves (alkaloid: cocaine) or smoking tobacco leaves (alkaloid: nicotine) which were not only available but also used as stimulants at that time in the New World. Furthermore, it was reported by some who visited Montezuma's court that an additional attractive feature was that cacao was felt to have aphrodisiac properties.

In any case, cacao beans were so important at the time of European discovery that these, not gold and silver, were used as money. Ovedio, a Spaniard who reported extensively on this era, indicated that in the markets in Nicaragua, "a rabbit could be purchased for ten cacao beans, a horse or mule for fifty beans and a rather good slave for a hundred beans. He added that no one but the wealthy could afford to consume the cacao drink, for it was like drinking money.

Each group of European colonists tried to exploit the cacao crop for their own interests. The Spaniards, who first discovered its use, endeavored to keep its source a secret so they would have a monopoly. It didn't work out, however, for soon cacao was planted in Martinique (France), Brazil (Portugal), and Trinidad (England). Then the European and later the United States governments began to tax the import of beans so highly that once again only the wealthy could relish cacao. Yet, despite monopolies and taxes, Chocolate Houses became increasingly popular in Europe, and thus production of cacao in the tropical countries of Latin America was encouraged to keep pace with the demand.

In Europe, one of the primary reasons for cacao's popularity was the belief that chocolate was an aphrodisiac. In this connection, it is interesting to note that recent research suggests that certain compounds in the cacao bean may indeed influence pleasure centers in the brain.

Demand was further encouraged because the drink was recommended by many physicians for its stimulating effect on anemic patients. It is interesting to note that two men who did much to develop the cocoa business in the nineteenth century were medical men: Dr. Joseph Fry in England and Dr. James Baker in the United States. Frys and Bakers are still leading chocolate companies.

The key innovation in chocolate's use —and one is surprised that it took so long in coming — was when people like Van Hooten in Holland and Suchard and Peter in Switzerland began to experiment with removing the fat, or cocoa butter, from the beans. They then added such things as sugar, milk, and fruit. In addition, alkali to darken the mixture and often potato or corn starch as cheap fillers were thrown in by many an unscrupulous chocolate manufacturer. Richard Cadbury, writing under the name of "Historicus" in his book, *Cacao: All about It,* deplored the addition of alkali since he felt that it gave a "deceptive value to the cocoa by darkening its colour in the cup." Today, however, Cadbury's and probably every other manufacturer uses carbonate or bicarbonate during the elaboration process.

By tearing the cocoa bean apart and then putting the pieces back together again with new ingredients, manufacturers opened up a whole new world for themselves, including Roundtree in England, Menier in France and Hershey in the United States. Drinking the pulverized bean was not the only way to enjoy this gift from heaven. Now, cocoa beans could be prepared so that the resulting product could be molded and eaten as a candy or could be the basic flavoring in ice cream, cake and other sweets. Later, the varied uses of cocoa butter for skin creams, suppositories and in special confectionery preparations would be discovered.

The cacao tree evolved in the shaded understory of the humid tropical forests of South America. Without shade, particularly when in its juvenile state, growth and development tend to be hampered to such a state that the seedling tree often dies. In a shady environment it may grow to between five and eight meters (fifteen to twenty-five feet) in height. However, it does have the capacity of sending up new shoots called chupons which appear as though they were new trees growing out of the top of the old. If there is too much shade, the tree can send up one, two, three, and even four extra stories in its attempt to find more light. A seedling usually grows about four or five feet tall as a single stem or trunk. It then sends out four to six laterally developing or plageotropic branches in what is known as a "jorquette." These branches expand in length and girth giving a cacao tree the shape of a champagne glass.

A curious and novel aspect of the tree is its manner of flowering and fruiting. Floral buds develop from the bark of any

A harvest of cacao fruit, ready to be split open with knife or machete, to extract the beans. Different varieties of cacao often have different coloration to the mature pods, as dramatically illustrated here.





part of the tree which is at least two years old. When the fruit or pods develop from these flowers they give the appearance of growing right out of the trunk and branches. Young pods are generally either greenish or maroon in color and turn yellow or orange-red when mature. They have a variety of shapes and can be smooth or ridged, but most have an elliptic form resembling a small American football.

While cacao trees can put out thousands of flowers, these are difficult to pollinate and only small insects called midges are able to carry out the task. In addition, many trees have a genetic make-up which renders them self-incompatible; that is, the pollen from the flower cannot fertilize the ovary of the same flower. On the surface, this may appear to be dead evolution, but indeed, if plants could think, this is rather good thinking on the part of certain cacao populations. If a cacao tree can't cross with itself, yet does produce fruit, this must be the result of what is called an outcross. This strategy leads to a better dispersal of the progeny than if there were only self-compatible plants. Without outcrossing, cacao trees would tend to grow in clumps and would be defenseless against disease. With outcrossing, the trees not only have a chance to scatter but also have a better genetic potential to exist in new and different environments, all of which enhance the individual organism's ability to survive.

In an attempt to overcome all of these problems and assure future cacao generations, a mature tree puts out thousands of flowers annually, a considerable use of the plant's resources. Of the flowers produced each year, only a maximum of about ten percent get pollinated; the rest wither and drop off. Of those formed many, too, will drop off due to a physiological and nutritional syndrome known as Cherelle Wilt. Often as many as eighty percent of the little pods formed will shrivel and become dry and black — a natural abortion.

The remaining pods, if properly nourished by the tree, mature, and when ripe become attractive to all manner of birds and animals. Immature pods with their dull reddish or green color are somewhat difficult to distinguish from branches and leaves. However, when these pods ripen and the color changes to bright orange, reddish yellow and yellow, they can easily be spotted even in the dark understory.

Another phase of the complex strategy of survival of the cacao tree is that the pods are so developed to protect the seed they cannot open unless some outside source cracks or chews or picks them open. The pods will not even fall off the tree until long after the seeds inside have germinated, sprouted and then died from lack of nutrients and light. The bright colors of ripe pods in the dark, monotonous undergrowth of the tropical rainforest are targets. Anything which zeroes in on these targets and can open the husk of the pod is rewarded by the sweet-tasting mucilaginous covering on each fully developed seed. Usually whatever breaks into the pod does so only for this seed covering, since the seeds themselves tend to be astringent and bitter. Thus, toucans, bats, squirrels, monkeys and parrots go after the ripe pods, bite and claw them open, consume the seed covering and in so doing dribble and scatter the seeds all over the forest floor where they germinate and start new cacao trees. This scheme, a form of co-evolution, may be an excellent mechanism for seed dispersal, but it is not the sort of thing a farmer appreciates when striving for a larger harvest of cacao.

A cacao tree in its prime on good soil may overcome many of the previously described hurdles and produce about a hundred ripe pods a year. But any farmer considers himself fortunate if out of these hundred pods formed he is able to harvest thirty or forty per tree. The difference is lost to insect attack, bats, birds, monkeys and a multitude of diseases — and theft. It takes ten pods, on the average, to make a pound of dry cacao beans.

Harvesting ripe pods is one of the least onerous tasks in tropical agriculture. The job is done in the shade where it is reasonably cool, and it is not strenuous work. Once the pods have been cut from the branches and trunk with a sharp cutting tool, they are gathered into mounds throughout the farm or else at some central location where they are cut open with a machete or cracked open with a wooden mallet. This is often done by groups of men and women sitting around the mound of pods opening them, scooping the seeds into some kind of container,



Page 16, left: Fruit (pods) maturing on cacao tree. Note cauliflorous condition.

Page 16, right: Open flower, and several buds, in various stages of development on cacao tree. Note that several buds are developing from one cushion on the branch.

Left: Close-up view of a maturing fruit (pod) on a cacao tree. When mature, the fruit does not drop off the tree. Rather, it must be removed by an animal (or man). Each mature fruit contains many almond-size seeds (cacao beans), the source of cocoa and chocolate.

and throwing the husks into another pile to decay. The overall operation and setting provide a marvelous opportunity for singing, telling stories and gossip. From a modern agri-business standpoint, it is by no means an efficient system and too much time is wasted in something a machine could probably do much more efficiently and cheaply. It is interesting to note, however, that no such machine has been successfully developed to operate on cacao farms anywhere in the world. If one believes that necessity is the mother of invention, this fact tends to confirm that commercial cacao production is still based primarily on inexpensive hand labor and that there is still sufficient "cheap" labor available in most cacao growing areas to obviate the necessity of inventing a pod-cracking machine.

Once the beans have been removed from the pods they should be fermented. During fermentation, a variety of things happens. The first is that anaerobic micro-organisms operating in the absence of air, using the sweet mucilaginous covering of the seeds as their energy source, convert this to alcohol. It is the same fermentation which takes place in the production of wine. In many localities, this process is enhanced by placing the beans in a covered wooden box or container or else covering a pile of beans with burlap bags and banana leaves. In a day or a day and a half, this process is completed and when the pulp cells surrounding the beans collapse as the sugars in the seed covering are used up, air enters and another type of fermentation takes over. This aerobic process is improved by actually turning or stirring the mass of cacao beans so that they become well-aerated. It is like pulling the cork out of a bottle of wine and leaving it to turn to vinegar.

Aerobic fermentation is one in which a new shift of micro-organisms takes over, this time by species which need oxygen and are able to utilize alcohol as their energy source, converting this to acetic acid or vinegar. During this part of the process, the temperature of the mass can go up to somewhere between 48° and 50° centigrade (about 120°F). This high temperature, coupled with the penetration of the seed itself by alcohols and acetic acid, not only kills the embryo but also stimulates a series of biochemical changes which brings out the true chocolate taste and aroma. At the same time, the beans become less astringent and change from a purple to a chocolate-brown color. Well-fermented beans make the best chocolate.

Fermentation decreases the weight of the dry beans by about two to four percent, however, and thus this step is bypassed in many parts of the tropical world. Too often, farmers are paid for cacao beans strictly by weight, not quality, so there is little incentive to spend time, effort and money on the fermentation process.

The final stage of cacao processing consists in drying the beans down to about seven percent moisture. Purchasers of cacao beans want to buy as little water as possible and furthermore, dry beans won't mold. Beans with moisture contents even slightly higher than eight to nine percent will mold in storage and this absolutely ruins the beans for the chocolate manufacturer. In the humid tropics where cacao does best, it is difficult, if not impossible, to achieve this state of dryness without very sophisticated equipment, something the majority of small cacao growers just don't own. They are either lucky with the sun, pay for someone else to do the job for them, or sell moldy beans at a great loss. The oil from cacao beans, moldy or not, is cacao butter which makes up about fifty to fifty-five percent by weight of the beans. In the case of moldy beans, this fraction may be used but the other forty-five to fifty percent is lost. In addition, government inspectors will not permit entry into the United States of any beans which show more than a minimum level of mold and insect damage. This implies the added expense of shipment to Holland or Spain where firms specialize in taking what they can out of poor quality beans.

Wherever possible, drying is done by utilizing the sun. The beans are spread out on any kind of suitable mat or tray or platform. Often these sun driers have facilities for some kind of heat (from fuel oil, kindling, coconut husks) to be forced or blown through the mass of beans to speed up the process. Of course, driers of this type with a moveable roof are indispensable during periods of rainy or cloudy weather. Large scale farms have modern crop drying systems, but only about twenty percent of the world's pro-

duction of cacao comes from large-scale modern farms.

Under proper care and management, under the proper climatic conditions and on the best soils, cacao trees can produce as much as a ton of cacao beans per acre per year. The world average, however, is much closer to 200 pounds per acre. On the majority of farms, few inputs are used outside of the farmer's own labor. To obtain high yields it can easily take from three to four thousand dollars an acre just to bring a plantation into bearing and very few cacao farmers have this money.

Cacao is one of those agricultural commodities whose price fluctuates in a very volatile manner. Dry weather in Malaysia, wars or revolutions in Africa, diseases in Latin America, alternative land-use in the Caribbean, interest rates, and consumer resistance based on some new diet fad are all influential. Furthermore, the individual farmer or even the manager of a large farm has absolutely no influence over the market and bases his particuar decision as to whether to plant cacao or not on what he receives for his crop and estimates what he may receive for it in the future.

Although cacao is pan-tropic today, most of its worldwide distribution has been of a relatively recent nature. To paint a general yet composite picture of this tree and its crop and the nature of the problems with which it is associated, it is probably best to describe one small but typical region where cacao has been grown for a long time. Since Costa Rica is one of the areas which has been postulated as a center of origin of cultivated cacao, since we know it supplied Montezuma with beans and since it is still a producing area, it can serve as our example.

After European settlement of this small Central American country, cacao continued to be one of the principal export crops. The new owners of these agricultural enterprises, descendants of the Conquistadors, prized their plantations but visited them only once or twice a year to collect the crop and make arrangements for the following year. It was typical that an expedition would be mounted from the then capital city of Cartago to go down to the Atlantic lowlands, chiefly in the vicinity of the Matina river, which gave its name to a special type of cacao. These excursions, complete with pack animals and guards, almost always took place during February or March when the weather was driest and when it was reported that the cacao growing areas were virtually free of malaria and yellow fever.

Some additional plantings were made along the banks of the rivers and always with the same "Matina" type cacao. Although disease and such pests as squirrels cut into production, during the Colonial Period in Central America many of the best families in Costa Rica were involved in cacao growing and dowries were often in the form of cacao farms. By the end of the seventeenth century, however, to all of the other problems seemingly inherent in the production of this crop, a new threat was added. Since the defeat of the Spanish Armada in 1588, English seamen began to take greater liberties with ships and even countries under the Spanish flag, climaxed in this particular case with almost annual raids into Costa Rica (still then a part of the Spanish Empire) at the time of cacao harvests to abscond with the crop. Chief among the buccaneers was Henry Morgan. This pirate, later knighted for his exploits, would dare to come as far as the town of Turrialba, almost to the capital city of Cartago, in search of booty. There was almost nothing the country could do since it had no army and the laborers of the region were loath to lay down their lives for someone else's cacao crop. Since there was little which could be done to prevent these piratical attacks, the loss of one or two entire harvests was enough to cause many a farmer to sell out. These plundering escapades probably did very little to promote cacao as a good risk venture.

People began to look to other crops, mainly coffee and bananas. Reduced coffee production in the Dutch Indies (Java) due to the fungus *Hemileia vastatrix*, which causes rust, was a boon to Costa Rica with its desperate need for an additional export crop.

But there was no railroad in the country and coffee was being shipped to the Pacific coast of Puntarenas by ox carts. Once aboard ship the cargo was transported around the tip of South America, Cape Horn, to reach the best markets. This problem was to be solved by the building of a railroad in the late nineteenth century. A young American, Minor C. Keith, was the contractor for the job.

Keith had financial troubles in the difficult task of railroad building—malaria, yellow fever, machete fights, dysentery among them—and he concluded he needed an immediate additional money crop to plant along his incipient railroad line. His investigations proved that bananas were profitable in the United States. He planted them and soon their healthy cash flow enabled him to complete the railroad. Keith parlayed this venture into United Fruit Company. Now bananas and coffee were so important that few remained who continued to plant cacao.

But in 1916, a disease was discovered in the plantations of United just across the border in Panama. This disease, caused by an organism known as *Fusarium cubense* but more popularly "mal de Panama," or the Panama disease, was paticularly attracted to the Gros Michel type then being grown in Costa Rica. Once sricken, these bananas would literally wilt and collapse in a matter of days. Exports of the fruit began to decrease and by 1926 were down to only a million stems a year.

Many efforts were made to control the disease, but this was not an easy process and soon most of the land formerly planted to bananas was abandoned. A decision was finally made by United to plant areas in cacao where bananas would not grow. It was reasoned that this crop had always been there and, besides, there was an increasing demand for cacao beans on the world market, chiefly from nearby Colombia, where drinking chocolate had been a tradition for many years, but Colombia had never managed to be able to supply its own demand.

The stage was thus set for a massive planting of cacao trees on land which had been opened up to help coffee farmers, but had first been planted to bananas. The best varieties from other countries were brought to Costa Rica, fortunately without bringing any disease, and these together with selections of the best cacao growing material from Costa Rica itself were planted out by the thousands of acres on abandoned banana lands. Large scale fermentaries and dryers were built in Limon and also at Almirante, just across the border in Panama, to provide the best possible processing of the beans for export. Later, a similar facility was established on the Pacific coast when the bananas planted there were also decimated by the Panama disease and cacao was planted to replace them.

By 1948, Costa Rica had planted over 70,000 hectares (about 172,000 acres) to cacao and during at least one year of the next decade did manage to export 16,000 metric tons of cacao beans. It probably produced more, since many uncounted beans found their way across the borders into Nicaragua and Panama, and a modest number were used in the two local chocolate factories in San Jose. This made Costa Rica the world's tenth largest producer of cacao beans at that time although its entire production was only about one to two percent of the world's total.

Then, as acreage increased and old plantations brought back to bearing, problems such as disease and insect attack also began to increase. The chief disease was "black pod," caused by the ubiquitous pathenogenic organism known as *Phytophthora* which, depending on the species, causes potato blight, tomato wilt, and can be lethal to hundreds of different kinds of plants throughout the world. It could wipe out fifty to eighty percent of a cacao harvest if the trees were not sprayed and fifteen to thirty percent even if the plantation had disease control.

Despite the promises after World War II of the chocolate manufacturers to help producing areas and not let prices of cacao beans drop too far, that price fall is exactly what happened, and as the price



Bringing cacao pods in from the field to a central collection area in sacks on the back of a mule.

decreased and disease, theft, and loss to animals and birds increased, farmers lost interest in the crop. United, which had the largest acreage, began to cut down on proper control and maintenance, and then started to turn land over to former employees as they terminated their work contracts. United also returned land to the Costa Rican government. Finally, operations at the fermentary and dryer in Limon were shut down. The dryer and fermentary on the Pacific side was dismantled and the cacao cut down, even before it reached its point of optimum productivity, and the land was planted to oil palm.

To add to all of this, the government charged a tax of thirteen percent on all cacao beans exported from the country. Ostensibly, funds derived were to provide for improving roads, schools, hospitals, and so on in the cacao growing areas. Following the government example, the province of Limon levied an additional three percent tax, but the idea of improving the social overhead capital of the cacao growing regions became a myth as the taxes disappeared into the governmental and provincial treasuries.

As cacao prices fluctuated and dropped to new lows during the '50s and '60s, fresh life was brought to the area in the form of a variety of banana which was resistant to Panama disease. Since the time that this disease had first struck, research had been going on to find a resistant form which would be accepted by the consuming public, and bananas were by now well-known and accepted as a basic fruit throughout the world. The Valery or dwarf Cavendish was resistant or at least tolerant to the disease, and also due to its size tended to resist blowdowns.

Banana fever once again took hold. Old lands, new lands, and even land planted to cacao were cleared in preparation for planting bananas again. Banks appeared to have ample funds for this type of agribusiness. Fruit companies were eager to sign contracts.

Despite sporadic efforts on the part of International Development Programs (rather than the Ministry of Agriculture which assigned its best technicians to coffee research and extension) to do something about cacao development, production of this crop continued to decline until it was being exported in the four thousand metric ton range. Cacao came to be thought of as a miserable crop.

This was the case now throughout the cacao-growing areas of the tropical world. And since so little was generally known about the matter, people ate their chocolate bars and never connected the candy and its price with the cacao producer. This attitude was well-described by the wife of an official of a large chocolate manufacturing company on her first visit to a cacao farm when she exclaimed, after seeing a miserable row of worker's shacks, "Do you mean that this is what supports all those fancy salaries and air-conditioned offices back home?"

In Costa Rica, bananas had moved in again and once more it was cacao which was pushed aside. In West Africa, the small farmer found out that regardless of the price in the outside world, he got the same return for cacao; the Cocoa Marketing Boards of the former colonies, but now countries, took up the difference. The result has been that in many areas there, cacao was cut down and food crops planted which were sold for a better return on the local market. In Trinidad, there is more money to be made in the tourist industry in Port-of-Spain than out in the cocoa fields and a survey conducted only a few years ago indicated that the youngest cacao farmer there was fifty-eight years old.

But the fickle and volatile price for this commodity took a sudden change in the early 1970s and went up like a rocket. Part of this was due to the fact that production had dropped, part was due to the economic euphoria of the '60s, and part was due to the fact that Russia and other Iron Curtain countries began to import more cacao. Then, as inflation took hold and the dollar lost ground on world markets, hedging in commodities, cacao included, drove the price up even further. By 1976, when the price had gotten up to one dollar a pound, producers again became interested in improving their farms and even in planting a new crop of cacao.

There were now new varieties of "hy

brid" cacao which showed definite promise of disease resistance, precosity or early bearing and high productivity. With improved prices at the farm, the owner or at least the manager could afford to spend money on fertilizers, spray materials, increased labor costs, and still come out ahead. In addition, in some instances, governments, particularly Brazil and Malaysia, developed strong programs for farmer assistance. These countries also taxed cacao beans leaving their shores, but they actually used this money for extension work, new farm to market roads, cacao research and development.

When a 10,000,000 pound crop was predicted for Costa Rica for 1979 by Gill and Duffus, a leading trade journal for this industry, the government even decided to loosen up a bit on the amount of credit available for cacao farmers in the Atlantic zone. With all of this, production increased as the price increased and there were, in addition, more areas going into new plantings. Older plantings also, were being worked on for the first time in many years. Part of this was because tables were beginning to turn once again and the return on banana farming owing to competition from other countries was not so attractive as before. It appeared as though cacao, the gift of the gods, had finally come into its own and at a very favorable price, since by 1978 it reached two dollars a pound.

But just when things looked brightest, the cacao plantations and farms of Costa Rica were hit by something entirely new and completely unexpected which some of the more pessimistic feel may finally sound the death knell for this crop as a thriving agro-industry in Central America and Mexico.

It was in late December of 1978 when I heard a rumor that a virulent disease, new to Central America, had appeared in the cacao plantations of the eastern littoral of Costa Rica. I am not a plant pathologist, but sufficient experience with this crop in many parts of the tropics gave me a pretty good idea of what this disease might be, and furthermore made me realize what could be in store for Costa Rica and indeed all of the cacao growing regions of Central America and Mexico. My suspicions that it was *Moniliasis* were quickly confirmed. It was the first instance of this disease to be recorded north of Colombia.

Moniliasis is rather peculiar in that it is quite specific and has been found to attack only the fruit of cacao trees. It is a fungus and was unknown until the second decade of this century when, aided by another disease with the enchanting name of Witches Broom, it reached such plague proportion in the cacao plantations of Ecuador that production declined from 50,000 tons of beans in 1915 to less than 15,000 tons in 1930. Dr. James Rorer made an inspection trip to the Quevado area of Ecuador early during the outbreak and in 1918, described the causal organism, something about its epidemology and the symptoms of the pods under attack. For his efforts, he had the fungus which causes the disease named after him: *Monilia roreri*. The disease itself is properly called *Moniliasis* but it is almost universally and incorrectly called "monilia" in English, Spanish, and Portuguese in the cacao-growing areas throughout this hemisphere.

Within economic limits, no effective chemical control has been discovered. The least expensive and most successful means of dealing with *Moniliasis* is to carefully enclose infected pods in paper bags, to impede spore movement, remove the pods enclosed in these bags from the trees and bury the pods, bag and all. However, this business of collecting and burying infected fruit is not only tedious and



A farm couple opening cacao pods. The boxes which they are filling with fresh beans are of a standard size and when full hold 33 kilos. This same quantity converts to 33 pounds of dry fermented beans.



A simple farm drier with a movable roof. Fresh beans, on the left, are hardly fermented and will soon be spread out to dry together with the other beans on the right side of the platform. The owner's house is in the background.



A large scale sun drier where the drying trays are on rails and can be moved under a roof in case of inclement weather.

time consuming but a costly task as well. Only those farmers who are conscientious and good managers can be counted on to carry out this prophylactic operation as a regular part of their farm plan. Furthermore, in most cacao growing areas, this doesn't mean too much if one's neighbors don't do the same thing.

As soon as pods become infected they may be considered as good as lost from a commercial standpoint, because by the time they would have grown enough to produce mature beans, these would have already become a fetid watery mess. Although, as in the case of cacao, infection usually implies death, this is not always the end result of fungal attack. But if fungi don't kill they can be quite disturbing to the organism infected — ask anyone who suffers from something as common as athlete's foot.

One might ask at this point whether the disease had been around for some time or did it break out in much the same way many of us must have imagined the Legionnaire's Disease sprang full blown from the bowels of the Bellevue-Stratford Hotel in Philadelphia. Actually, there is a sort of analogy here. Almost certainly *Monilia* had been in existence for many years in one of the special ecological niches provided by the many protected mountain and valley systems of the Andes in Ecuador. It lived its days out on the few pods provided by a limited number of cacao trees scattered through the same valley system. It wasn't until recently that the demand for cacao was such that large acreages of only cacao trees were developed.

Through the centuries, the fungus and the cacao tree had worked out a relationship which Dr. L.B. Slobodkin of SUNY at Stony Brook, describes as the strategy of the "prudent predator." The fundamental postulate is that the need to reproduce and continue the species is basic to all life. From this it follows that if the fungus were to destroy all of the cacao pods in its environment, it would face extinction since it would have eliminated the source of any new cacao trees and thus the food supply for future generations of *Monilia*. The trick is to attack with sufficient caution to guarantee survival of the resource base.

As cacao plantations were established in Ecuador and many cacao trees planted in limited areas, it was quite similar to bringing together a large number of Legionnaires to one central point where, by chance, an organism known as *Legionella pneumophila* lay in wait. Predatory organisms thrive in this kind of situation and when a spore of *Monilia* found its way out of its isolated valley in Ecuador to a cacao plantation, it could only spread like fire through a dry forest. By changing the jungle ecology from one of many diverse species of plants to that of just cacao and a few shade trees, man had so altered the ground rules for the static and stable relationship between the cacao trees and the fungus that the balance now swung in favor of the fungus. But this situation is not unique to the tropics. The fruit groves of California have obviously provided an excellent resource base for the Mediterranean Fruit Fly with similar disastrous and expensive results.

Dr. Gustavo Enríquez of the Tropical Center for Research and Training in Turrialba, was the one who first tentatively identified *Moniliasis* in Costa Rica in early December 1978. Since he is from Ecuador and had previous contact with the disease, he realized only too well how serious this outbreak was. He immediately invited Dr. Carmen Suarez in Ecuador to help make a positive identification, she being one of the world's leading authorities on the subject. Without this first step, there could be no clear cut program of eradication. Dr. Enríquez next informed local pathologists about this matter, but once Dr. Suarez confirmed his original suspicions, none of them appeared to be very interested in wanting to know how to control its spread — a further indication of lack of interest in cacao.

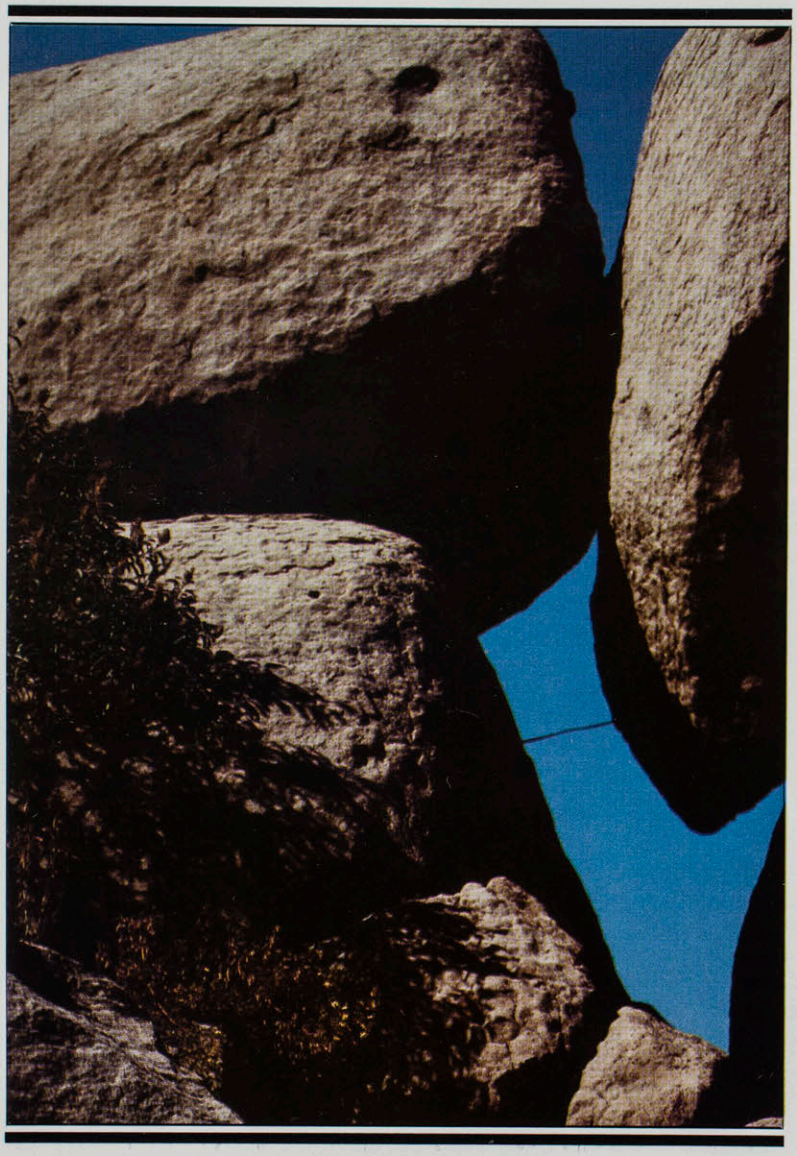
The local papers recently carried the story that *Monilia* has jumped over seemingly impenetrable and insurmountable mountain ranges to the northern borders of the country right next to Nicaragua. It is now reported to have infested that country. A few weeks later, the disease appeared in the southern part of Costa Rica on the Pacific coast. The fungus, in the space of about two years, had taken over a new country and was well on the way to moving through Nicaragua on up to Mexico.

If the price for cacao continues to drop to depressed and unprofitable levels for the farmer, if little or nothing is done to assist them with their production problems, and as work continues with developing such products as "CBS" — cacao butter substitutes — a more accurate scenario for the future of this crop is that cacao and chocolate may begin to disappear from the diet of many. One day it may be that only the rich may continue to consume this heavenly ambrosia from golden mugs, using finely-wrought tortoise shell spoons.

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A TARWEED IN THE "GARDEN OF THE GODS"

A Valedictory



Photographs by the author.

Boulders of sandstone in The Garden of the Gods with the Santa Susana tarweed at the base.

by WILLIAM A. EMBODEN

"Tarweeds" are those plants that produce a sticky resin over the surfaces of their leaves and stems. There are numerous genera and species that fall under this common epithet, but *Hemizonia minthornii* is unique. A member of the sunflower family (Asteraceae), this small shrub has as its distant relatives a series of common desert annuals to the east of it, and to the west it has relatives on the California islands. The closest ally is *Hemizonia clementina* which is found on several of these offshore islands.

Known as the Santa Susana tarweed, *Hemizonia minthornii* is found exclusively on sun-baked sandstone rocks and cliffs in one pocket of the mountain range that separates Los Angeles from Ventura and overlooks the whole of the greater San Fernando Valley. More precisely, it is found at the terminus of Topanga Canyon Road in an area designated on topographic maps as "Garden of the Gods," and immediately around this area. Only one other exception has been reported, and that is one niche in the western Santa Monica Mountains on a single sandstone bluff.

When the plant first came to my attention it was because this rare tarweed was on some choice land being sought by real

estate developers who needed an environmental impact statement. My colleagues at the Natural History Museum of Los Angeles County as well as elsewhere had already told the developers that the unusual tarweed grew in the precise site that they wished to develop. I was being sought for a contrary opinion. I informed them that it was January and the plant, being an herbaceous perennial, revealed no growth during the winter months but could be ascertained as present in the area only by a few dried remains of the previous year's growth.

In the spring of 1979 I drove out to this site to ascertain the nature and extent of the Santa Susana tarweed. Passing the enormous outcropping known as "Stoney Point" I came to the glorious pile of rocks designated as "Garden of the Gods." It is undoubtedly one of the most beautiful natural rock formations in all of California. Just behind it all of the early "western" films were made for reason of the extraordinary natural scenery. No studio could reconstruct anything so massive and elegant. The site lived up to its name. It was here that the Chumash Indians lived in the southernmost extent of their range. Atop the great rock outcroppings I found several natural mortars where Indians could grind acorns while keeping a watch over the entire valley. This monumental scene could not help but impress any visitor to the area; it would be the ideal setting for a Wagner opera.

Since the tarweed does not usually bloom until late summer, I had to separate all of the green vegetation in the area from the tarweed. Its spring growth is a mass of dissected leaves that are quite unlike the small needle-shaped leaves of fall and early winter. This heteromorphic condition has often made it difficult for botanists to find the plant. I relied upon the knowledge that it would be on, or at the base of, sandstone rocks. Moreover, using the beagle-like powers of my proboscis I fondled the vegetation to elicit the pine and lemon scent that is so characteristic of the tarweed. I was able to locate only a few plants near some of the largest rocks. They regularly faced the south and southwest and were anchored by taproots into the sandstone. A few could be found projecting out of the rocks in fissures.

In this area at the northwestern end of the San Fernando Valley, late summer temperatures may exceed 120 degrees Fahrenheit in the sun. The delicate, dissected leaves did not seem to be characteristic of a plant that could withstand such extraordinary temperatures, coupled with California's usual summer droughts. The fragrance was exhilarating as I stroked the plant in affectionate botanical appreciation. In earlier studies of the sages of that area (the genus *Salvia*) I had found that the emission of volatile oils from glands on the leaves reduced the incident lighting considerably, and cut the water loss from leaf surface evaporation (transpiration) by a factor of 13 to 14 percent. There was also the possibility that the same oils were inhibiting the growth of surrounding vegetation (allelopathy) giving the seedlings of *Hemizonia* some advantage in the early stages of growth. The latter remains to be substantiated. In the world of plants, it is impossible to escape your competition and predators, so the best solution is to have these adaptive features that frustrate and deter other plant and animal species.

I consulted my field notebook and found that the first specimens of this rare species were collected by David Keck on "Old Santa Susana Pass." I drove to the south and left Topanga Boulevard on a narrow road that shifts through rocks in a westerly direction. Along the roadside and adjacent hills a few more specimens were detected. It became apparent that the plants were scattered about in an area of several square miles.

In an effort to explore the totality of the range, I returned in September of 1980 with a graduate student, Ossi Meyn. During four hot days of September we explored hundreds of square miles to get an idea of the total range. It became apparent that the plant was limited to a few square miles, and within these it was only around sandstone bluffs or rocks. Fortunately I had the good sense to carry my camera with me on each trip, and I have documented the various developmental stages in the growth of the plant as well as its habit and habitat. In September it is much easier to spot the plants as they exhibit bright yellow flowers borne in abundance. These stand out against the deep olive and brown of the rest of the vegetation.

Lest these efforts sound too heroic, I must add that we always carried a picnic and in midday we retired to the shadow of a rock and shared a bottle of champagne and various delicacies that are the specialty of Ossi Meyn. She has the extraordinary feature of being both a fine botanist and an unusually imaginative chef. Our field trips followed the example of Linnaeus who in the eighteenth century began his forays into the fields with a lecture, followed by music and terminating in an herbation. Herbations were feasts without parallel. We tried to observe the amenities of our predecessor and with the exception of music, we set a fine example for our century. The only sounds were those of a stoney bluff being dynamited to prepare the surrounding area for more housing. At least one such "estate" of mobile homes has already obliterated a part of the range of the tarweed. A range that is the only known locale in the entire world!

We noted that the plants were now darker green and the pale green, dissected, juvenile foliage had given way to



S.E.M. (scanning electron micrograph) image of a glandular hair on a mature tarweed leaf: the source of oils.



S.E.M. view of a sterile hair from a juvenile tarweed leaf.



S.E.M. "landscape" of sterile hairs on juvenile foliage.

S.E.M. exhibiting non-glandular hairs in the foreground (leaf) and young oil-producing hairs on the stem in the background.





Above: Two growth phases of the tarweed's foliage (the dissected leaves are juvenile.)



Above: The rocky sandstone cliffs and bluffs have tarweeds growing in their crevices.

Below: A detail of the inflorescence of the Santa Susana tarweed.



Below: A mature Hemizonia minthornii *plant.*



thick obovate to needle-like leaves. It was a plant totally unlike that encountered in the spring.

I gathered mature foliage and on one plant I was able to find a branch of juvenile leaves. Taking these back to California State University, Northridge, I worked with Richard Chao in preparing these for study in scanning electron microscopy. With this instrumentation, we could study the leaf surfaces in detail and ascertain the types of glands that are present. The three dimensional aspect of these micrographs is presented here for the first time. The long hairs (trichomes) are exemplary of spring growth while the mushroom-shaped glands (peltate trichomes) are more frequent on the fall foliage. The heavier resins of the peltate trichomes had coated the leaf surfaces uniformly. This is another adaptive feature that insures reduced water loss. The small mouths (stomates) on the leaf surfaces were surrounded by mounds of this resin. It became much clearer why it was possible for this rare tarweed to live in so precarious an environment of heat and drought. Attempts to provide it with fine soil and water under circumstances of cultivation have failed. It is highly adapted to the rigorous environment in which it has lived for several millions of years.

As I left the area on my last visit in the summer of 1982, I noted five real estate companies had posted their signs offering the land that is that of the rare Santa Susana tarweed and the Chumash Indian's territory. Stakes with ribbons on the hills made the divisions known. It was with remorse that I left the area.

Does the Santa Susana tarweed deserve to remain in these few residual niches throughout its limited range? If so, why? I believe that I have some good answers to these questions about the tarweed. Answers that might relate to other endangered species. It is not sufficient to simply state "it is endangered and rare." Biologists owe the public an explanation that goes beyond this statement, for the notion of an endangered species is beginning to annoy the public rather than rousing a clarion call that elicits sympathy.

We are being told that there are endangered plant and animal species in almost every locality and we are asked not

to develop these areas in order to preserve them from extinction. While that argument is enough for most biologists, it does not satisfy individuals who want housing, hydroelectric plants and recreational areas. It is even more unlikely that biologists will receive a warm reception when the absence of development takes jobs away from residents in the area. When an organism is able to be transplanted to another area, any pleas are going to fall upon deaf ears.

Plants have a harder time of it than animals for reason of a lack of identity between the public and the plant. When that plant has the suffix "weed" it is even more difficult to garner support on its behalf. In 1973 an international conference on endangered species included certain "weeds" in their lists and the outcry has still not been hushed.

In 1978 Dr. Edward S. Ayensu of the Smithsonian served as the North American chairman assembling data highlighting the threat to the world's plant species. He limited his list to 250 of the thousands of plant species on this continent known to be rare and endangered. In this *Red Data Book* those plants that were in the gravest danger or were particularly spectacular, useful, or interesting were included. The enumeration was of necessity brief. The Santa Susana tarweed has never made an endangered species list at the federal level, although the state of California has given it recognition as a rare and threatened species.

A lack of public sympathy is exemplified by the now famous case of Furbish's lousewort *(Pedicularis furbishiae)* which is found sporadically along a 120 mile stretch of St. John River in north Maine and New Brunswick. The area was scheduled to provide residents with a great deal of electrical energy by way of the Dickey-Lincoln hydroelectric project. It became apparent that the plant could be transplanted to other localities and would thrive. Although its distribution was through an area of spectacular wilderness, sentiment went against it. Letters to newspapers and magazines are best exemplified by one outraged citizen who wrote to *Time*, "...the species was thought to be extinct anyway — let's make it official and drown it under a few billion gallons of water." Such a lack of concern is understandable in the absence of any explanation to the public why Kate Furbish's lousewort was, and is, so important. The same may be said of the tarweed in the Garden of the Gods. Does it deserve to remain?

While limited chromosomal studies and some anatomical work have been conducted on *Hemizonia minthornii*, most of its detailed morphology, anatomy and chemistry remains unknown. It is established that this species will form hybrids with *Hemizonia clementina*. It is also known that the genus on the California islands comprises a limited plexus of species derived from a progenitor that was very much like our xeromorphic *Hemizonia minthornii* in the Santa Susana Mountains. The California botanist Sherwin Carlquist suggested in his 1965 book *Island Life* that diversification of species has occurred on the islands and that *H. clementina*, our Santa Susana tarweed's closest relative, is in the process of forming distinctive races — a step in the process of speciation. In his 1974 book *Island Biology*, Dr. Carlquist suggested that *H. clementina* should be studied with respect to vestiture, leaf shape, leaf size, leaf margin types and other characteristics to ascertain whether any of these features are adaptive in nature. If the answer were positive it would indicate that the plants are becoming keyed to particular habitats such as has occurred among species of *Hemizonia* in the Southern islands as well as in the desert.

What Dr. Carlquist has indicated is that *Hemizonia clementina*, like *H. minthornii*, is an excellent candidate for studying the processes of evolution in action. Evolution is not a doctrine nor is it an established body of unchanging fact. It is a theory with excellent supportive data that is still accruing from a variety of plant and animal sources. This information has allowed us to go far beyond the initial observations of Darwin and his contemporaries.

The Santa Susana tarweed offers one of the finest opportunities to uncover the mechanisms of evolution that have led to adaptive radiation in this genus as it occurs on the California islands. Dr. Carlquist has suggested that from this shrubby Santa Susana tarweed, by way of a series of now inundated archipelagos, the silverswords and their relatives in the Hawaiian Islands arose (the *Dubautia-Argyroxiphium-Wilksia* complex). Such an assertion is very plausible but will require further substantiation from research on all of these genera and their component species.

The limited studies in cytology and anatomy seem to substantiate this intriguing and ingenious hypothesis, but there are still numerous aspects of the Santa Susana tarweed that must be researched to vindicate the thesis of migration to Hawaii via archipelagos and subsequent adaptive radiation to produce the shrubby and rosete forms encountered in the three Hawaiian genera mentioned. It is mind boggling to imagine our demure tarweed as the ancestor of the noble Hawaiian silverswords.

At the time of this writing a study is being initiated at California State University, Northridge to further elucidate aspects of chemistry, palynology, allelopathy and anatomy of the Santa Susana tarweed. Will such a study be possible in the next few years? The answer is uncertain. These plants must be studied in their natural habitats as they do not lend themselves to cultivation. Although there is a National Seed Storage Laboratory at Fort Collins, Colorado where there are over 100,000 species of seed, every seed has requirements for germination and establishment. Once a habitat has disappeared the species has been eliminated. Also, we do not know the longevity of most seed for these many plant species.

The ravages of man are greater than those of nature. A fire swept through the Garden of the Gods in 1981, and yet in the spring of 1982 the tarweeds were more abundant than in previous years. Their competition with dominant shrubs had been reduced greatly and they sprouted with vigor. I scoured the range with blackened levis to get an indication of their frequency and vigor. More designations for housing development were in evidence. Will the tarweed and the home of the Chumash succumb to dynamite and mobile homes? Will we have enough time to document the evolutionary processes of this plant, or even to fully characterize the species? The future is most uncertain. The proposed U.S. fiscal budget for 1983, if adopted, would eliminate protection under the Endangered Species Act for all "plant and invertebrate species." This would be a terrible blow to the science of biology in general.

At this time we are losing about three species of plants and animals each day with an exponential increase. If this is not reversed, the loss could exceed one million species during our lifetimes or roughly during the next forty to fifty years. A species once lost is a unique genetic resevoir that cannot be replaced. "Extinction is forever" has become something of a cliché, but it is a concept that is not widely understood.

The Santa Susana tarweed, *Hemizonia minthornii*, is but one rare and endangered species holding the key to an understanding of an entire plexus of plant genera and species. The tarweed in the Garden of the Gods could reveal some of the most important and poorly understood concepts of speciation and evolution. One community group has already organized in an effort to preserve the plant and its habitat. Time, impending legislation, and a general lack of knowledge all conspire against the tarweed. As Will Cuppy said of the Dodo in his essay *How to become Extinct*, "The Dodo never had a chance. He seems to have been invented for the sole purpose of becoming extinct and that was all he was good for." Let us hope that this is not true of the Santa Susana tarweed.

William Emboden is a Professor of Biology at California State University Northridge, and is Research Associate in Botany at the Natural History Museum of Los Angeles County. He is also a Research Fellow at the Botanical Museum of Harvard University.



Apache Mountain Spirit Dance

AMERICAN INDIAN HERITAGE

Our Living Link with the Past

by SHELLEY STEPHENS

"They sure don't make 'em like they used to." That phrase is spoken more and more these days. Just don't say it around Mary Ann Ashley. She's a Navajo who weaves rugs in the centuries-old tradition of her ancestors. Mary Ann will be joining other Native Americans demonstrating their skills at the Natural History Museum's Eleventh Annual Native American Festival. This event, to be held December 8–12, 1982, is in recognition and, more importantly, in celebration of the culture of this continent's earliest known inhabitants.

The festival, which has grown steadily since its introduction in 1971, is planned and funded by the Museum's Ethnic Arts Shop as a gift to the Southern California community. Visitors have the opportunity to speak directly with a well-known author, take part in the Indian "friendship dance," and sample tasty Indian fry bread. They can attend a lecture by an eminent authority, watch craftspeople at work, and purchase Indian arts and crafts for their own collections. Education and entertainment combine to create an unusual museum experience.

The crafts demonstrations are among the most popular events of the festival. In addition to the more familiar Indian crafts, museum visitors have been able to observe more obscure ones as well. Last year Dorothy Trujillo traveled from Cochiti Pueblo in New Mexico to demonstrate the art of making ceramic "storyteller" figures and Mathilda Allison demonstrated the art of porcupine quill embroidery.

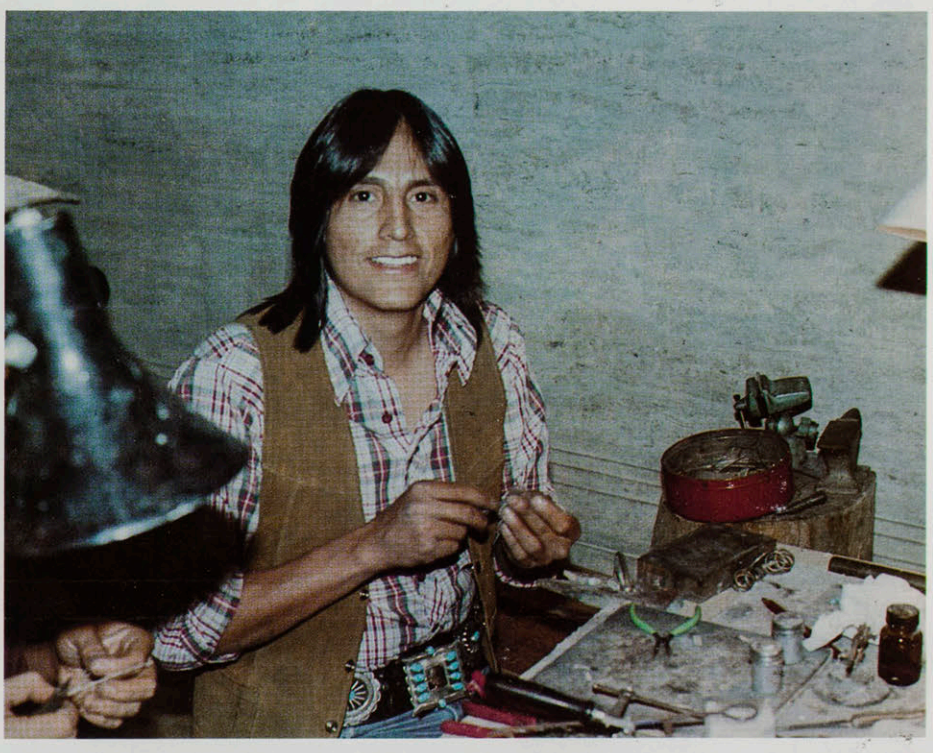
Navajo women have long been recognized as among the most creative and artistic textile makers in American history, and perennial festival favorite Mary Ann Ashley is no exception. She makes the annual trip from her home in Jeddito, Arizona, near Keams Canyon. She still raises her own sheep and processes their wool even though she is now in her late sixties. After the wool is cleaned, carded, spun and dyed, it is woven into the ancient Navajo patterns she learned from her mother and grandmother. One can watch her using virtually the identical loom and weaving techniques that have been handed down for over 300 years.



Mary Ann Ashley

Each year the staff eagerly awaits her return and mavels how, at her age, she can sit and work for hours in front of her loom without a complaint about aching muscles. She considers this trip her vacation; for Mary Ann "getting away from it all" means leaving the wilderness of northern Arizona and coming to downtown Los Angeles. She looks forward to chatting with the many children who visit the Museum as part of the school tours program. Invariably, a child will ask her if she is a "real" Indian.

Ray Tracey

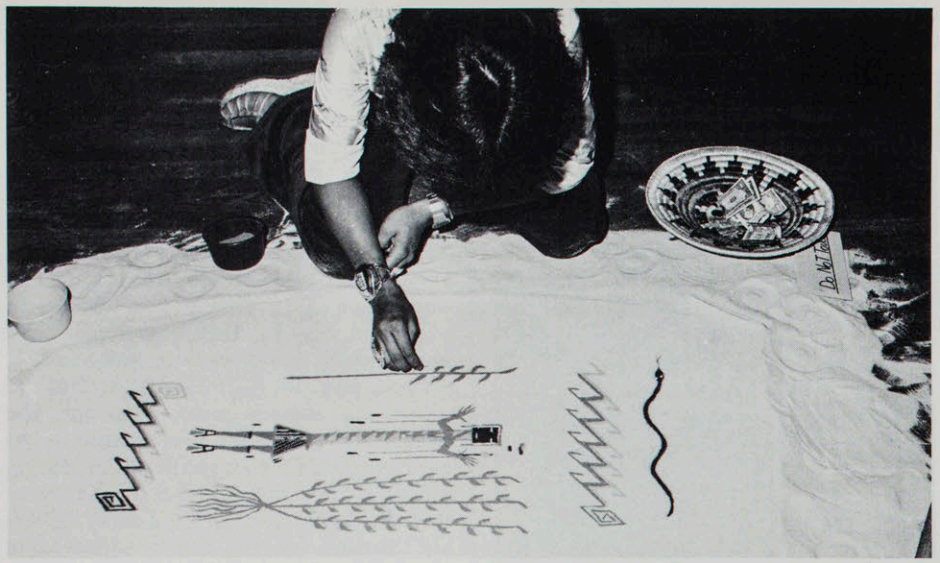


At the other end of the age spectrum is young silversmith Ray Tracey, who represents a synthesis of age-old techniques and new ideas. Ray joined the festival for the first time last year and will be back again this December. He learned silversmithing from his brother and grandfather while growing up in Fort Defiance, Arizona. Today, his inspiration for jewelry designs is often found in his dreams. He says that he will dream about bits and pieces, and then, during the day, his conscious imagination will take over and complete the designs. In addition to dreams, he finds that strong emotions, such as anger or joy, will trigger that sensitive, creative area of his mind and stimulate new design ideas.

However the inspiration arises, it's obvious that his pieces are impressive. At this year's Santa Fe Indian Market, he took first place in the Miniature Necklace Category and third place in the Major Necklace Category, and now his reputation is growing outside our national borders. There are galleries in Paris and Frankfurt that are clamoring for his designs.

In addition to seeing Ray at the Museum, you may also see him on the screen. Being a talented actor, as well as a talented silversmith, he was guest starred on such television series as "How the West was Won," "Lou Grant," "Hart to Hart," "Bret Maverick," "House Calls," and "Private Benjamin." He starred in the television movie "Centennial" and had a role in the feature movie "Seems Like Old Times" with Goldie Hawn. As if all this wasn't enough, he is also the recipient of this year's Outstanding American Indian award for his volunteer efforts with Indian youth.

Sandpainting

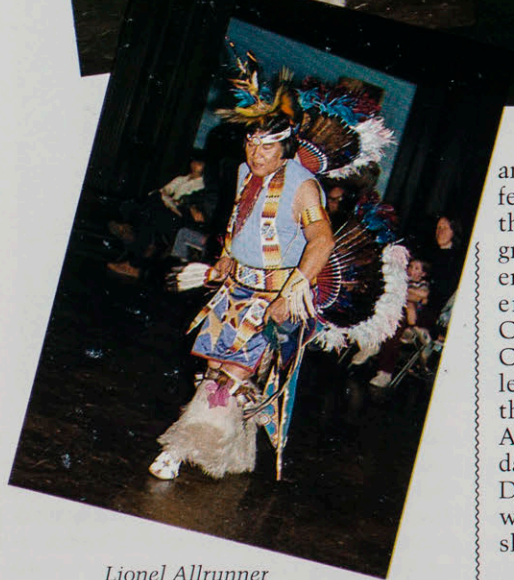


Another of the many crafts represented at the festival is Navajo sandpainting. Those who have marveled at the dazzling colors and intricate detail of sandpaintings can watch the creation of a work of art that is actually a "sermon in the sand." When ceremonially created, this process is part of a strict healing ritual performed by the Medicine Man to drive away disease and evil spirits and bring blessings and prosperity to the tribe. The appreciation for the beauty of these sandpaintings grows even more after watching sensitive fingers carefully sift the colored rock dust into the precise, symmetrical designs.

Carol Cisto (center) and her daughters

Bert Hall



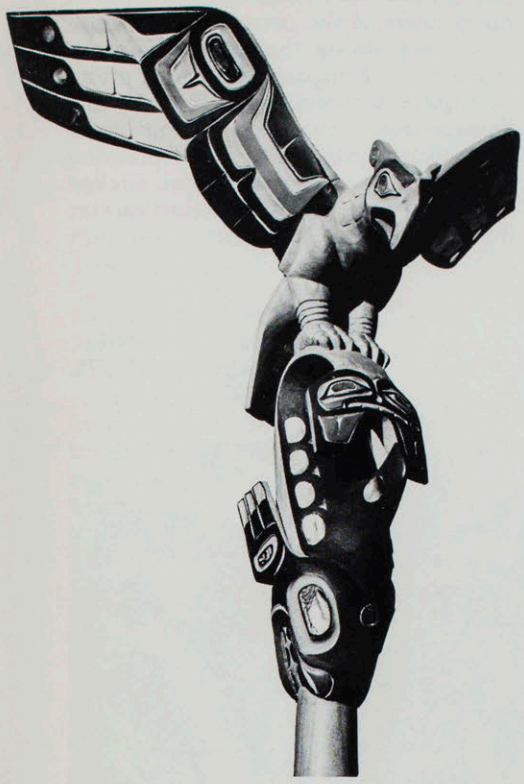


Lionel Allrunner

Ceremonial dance performances are another colorful and exciting part of the festival. These dances are performed by the Inter-Tribal Dancers of Los Angeles, a group made up of individuals from several different tribes. Among the performers are Lionel Allrunner, Southern Cheyenne; Bert Hall, Winnebago; Carol Cisto and Wanda Dawson, Navajo; and leader John Dawson is an Apache from the San Carlos Reservation in eastern Arizona. The group performs many dances such as the Swan Dance, the War Dance, and the difficult Hoop Dance, which requires a great degree of balance, skill, and practice.

John Dawson has also taught this group the dramatic and rarely performed Apache Mountain Spirit Dance. The dancers perform with their heads encased in black cloth, their upper bodies painted, wearing elaborate headdresses with symbolic designs. This dance is very meaningful and sacred to the Apache people; John says that, as far as he knows, his is the only group who has acquired permission to perform the dance outside of the reservation.

Come to the Museum and meet Mary Ann, Ray Tracey, and a host of other talented artists. This year's festival will present a full and varied program including craft workshops and storytelling sessions for children. It will also provide the Museum with the opportunity to showcase some of its finest acquisitions. Dr. Charles Rozaire of the Archaeology Section and Nancy Blomberg of the Ethnology Section have already begun work on a special exhibit of Native American pottery from the southwestern United States. Pieces from each of their collec-



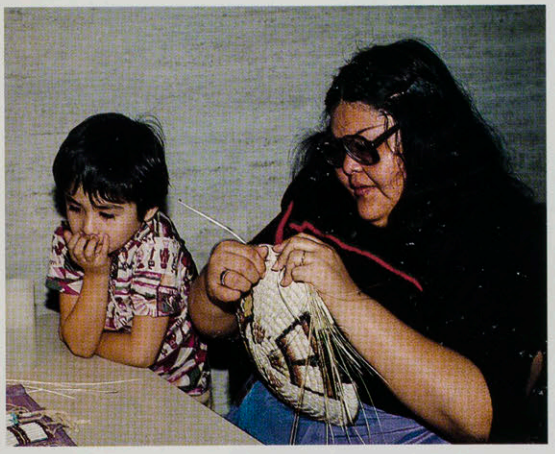
Speaker's Staff (artist: Lelooska)

tions will be displayed to show the stylistic transition from prehistoric to modern times.

A very special event is planned for the Alliance Members' preview opening on Tuesday evening, December 7, 1982. Those attending will be transported back in time to a potlatch ceremony at a Northwest Coast longhouse. Chief Don Lelooska and his family will be traveling from the state of Washington to present, with masks, costumes, and dance, a dramatic narrative program that communicates the folk tales, mythology, and beliefs of the native Northwest Coast people. Make plans now to attend.

This festival offers the opportunity for the public to view traditions that are on the edge of extinction. These traditions represent cultural values that are the antithesis of today's computer-chip society. The Native Americans' link with their time-honored past is a trait that has been left behind by much of the "modern world" and, for that reason alone, deserves our attention.

Shelley Stephens has held the title of Manager of Marketing Services at the Natural History Museum for the past six years. She oversees the operations of the Ethnic Art Shop, the Book Shop, and the Page Museum Shop. She has strong feelings about preserving the integrity of ethnic cultures around the world.



Debbie Kewanyama, Hopi basket weaver and her son



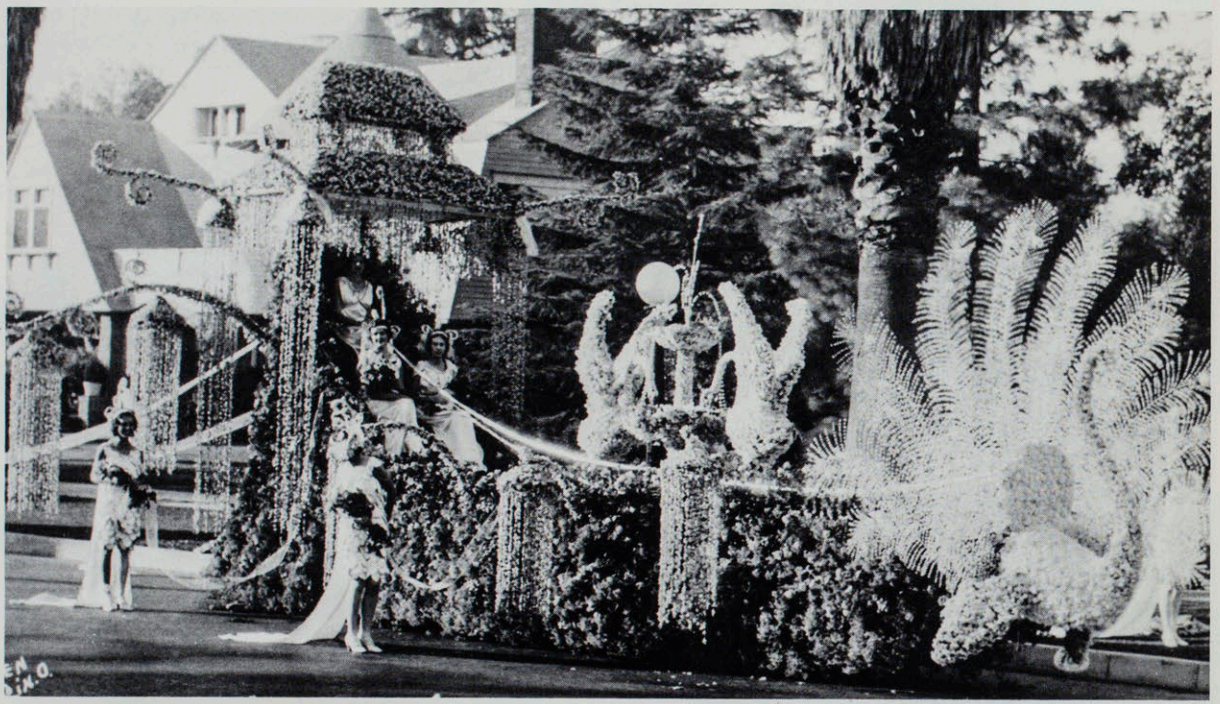
Chief Don Lelooska

(continued from page 2)

crease with each year that passes without the event occurring. (The probability also must be increased during any period in which short or intermediate term precursors are observed; however, this increase is at the present time difficult to evaluate with adequate precision. One goal of the U.S. earthquake prediction program is to remedy this deficiency.) The important point is that the background probability (2%) already has reached a level at which a well-planned and coordinated program of earthquake preparedness for Southern California is essential. Agencies of federal, state, and local governments have begun this preparedness process; however, only very limited funds are available for their work. The cooperation and participation of the general public is required for the success of these efforts. Every family and business should have its own earthquake preparedness plan. These plans need to provide both for survival during and immediately after the earthquake, and for longer term recovery.

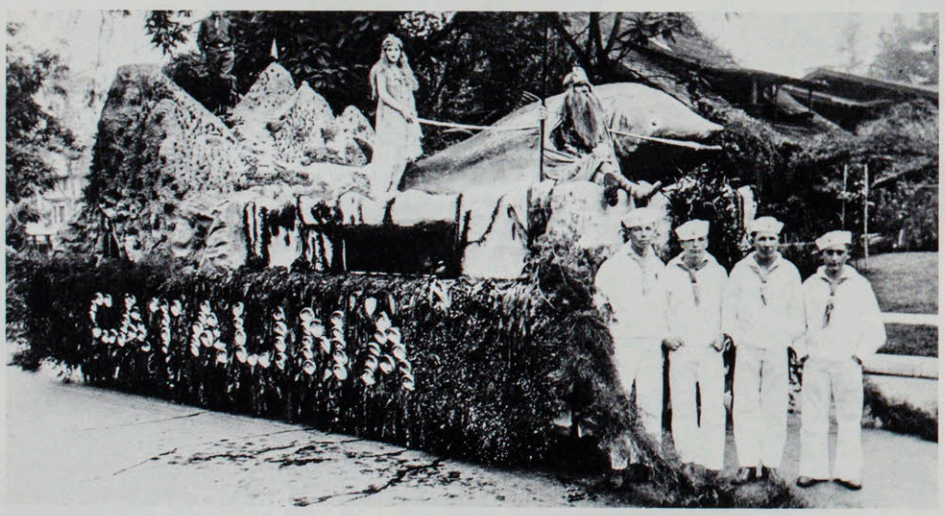
Our second point is that much of the damage which may result from an earthquake is caused by fire. Now that Southern California has become densely populated, there are hundreds of potential ignition sources per square mile in many areas of the counties which will experience strong shaking. The protection of fire fighting capability is an important factor in reducing the consequential damage from an earthquake. An operational earthquake prediction program could help to ensure that vital, lifeline services such as fire suppression survive the next great earthquake.

Sincerely,
Dr. Mark H. Shapiro
Dr. Thomas A. Tombrello
CALIFORNIA INSTITUTE OF TECHNOLOGY



Tournament of Roses, 1933 "The Peacock"— Long Beach Theme Prize Winner

Tournament of Roses, 1925 Catalina Island Prize Winner



CHRISTMAS EXHIBIT

The Museum's annual Christmas exhibit, which opens on November 16, has a uniquely Southern California flavor with pinatas, palm trees and blooming poinsettias—as well as a traditionally decorated evergreen and old-fashioned toys. Entitled "Holiday Greetings from Southern California," the display also features a special section of photographs portraying Southland responses to the holiday season, scenes of the Santa Claus Lane Parade, past Rose Bowl games—even our reactions to a December 25 heat wave! Continues through February 16, 1983.

BOOK REVIEW

Creation and Evolution: Myth or Reality? by Norman D. Newell (Columbia University Press, New York, 1982). Are the Sophists extinct? Indeed not, according to this book and other published reports. They are alive and well in the United States of America, having evolved into "scientific creationists," with an influential national organization composed of fundamentalist Christians dedicated to subverting the Constitution by forcing their concept of religion into the public schools. The current vehicle is Darwinian evolution vs. biblical creation. They argue that organic evolution is not only abhorrent (common ancestors for man and ape), but nonexistent, because species were created as described in Genesis and the fossil record is simply a gross misinterpretation of the sedimentary dregs left behind by the Noachian flood. They lobby hard and oc-

casionally successfully for having this view taught in public schools as science. Fortunately, a determined group of jurists, educators, scientists, and other concerned citizens are at hand to challenge them through the courts and in print.

Among these is Dr. Norman Newell, curator emeritus and a former departmental chairman at the American Museum of Natural History. Dr. Newell, a world-renowned paleontologist who has spent a lifetime researching and publishing on marine mollusks of the Paleozoic Era, says that he has written this book "for the millions of nonscientific people with a wide range of involvement in formal religion." In it, he carefully, but not condescendingly, explains what scientists have discovered about life in the past, citing well-documented examples and including photographs of sites and specimens, as well as numerous figures, tables, maps, and even cartoons. In the appropriate places, he explains how the views of creatonists differ and shows how they are wrong. For example, creationists assert that the Earth is about 10,000 years old, apparently based on seventeenth century calculations of biblical genealogies yielding a date for creation of Friday, September 17, 4004 B.C. (Adam created at nine A.M.). In contrast, scientists have calculated an age of 4.6 billion years for the earth. In our Museum's Hall of Marine Life, you can touch a fossiliferous cobble from a formation that has been dated radiometrically at 1.9 billion years old (Gunflint Chert from Minnesota).

And then the Flood. Nothing else in the Bible has given the creationists such trouble. If all species were created about 10,000 years ago, it follows that extinct kinds of animals and plants in the geological record simply must have been drowned in the Flood, they argue. Dr. Newell shows that there is not enough water on earth to raise the level of the oceans so that "the mountains were covered." So where did all the water come from? And where did it go? And why don't most of the rocks in the sedimentary record look like flood sediments deposited in a mere forty days? The answer, of course, is that neither the sediments nor their contained fossils can be explained in terms of such a flood.

Well-documented chapters cover other related topics, culminating in *The Origin of Species*.

Dr. Newell has handled the writing of this book admirably, although I do miss an index. It is recommended as reading for concerned school officials, moderate clergymen, newspaper editors, librarians, book dealers, and everyone else who might like to help combat the insidious spread of antiscience.

The book is available in the Museum Bookstore.

Edward C. Wilson
Curator of Invertebrate Paleontology

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